CHAPTER III
WITHOUT-PROJECT CONDITIONS

One of the most important elements of any water resource evaluation is defining the scope of problems to be solved and opportunities to be addressed. Significant in this process is defining existing resource conditions and how these conditions may change in the future. The magnitude of change not only influences the scope of the problems, needs, and opportunities, but the extent of related resources that could be influenced by possible actions taken to address them. Accordingly, presented below is a brief assessment of existing conditions, and estimated future without-project baseline conditions, in the primary and extended study areas.

EXISTING CONDITIONS

Existing physical, biological, social and economic, cultural, conditions are described in this section, focusing on the primary study area. Additional information on these conditions and conditions in the extended study area, including the Sacramento-San Joaquin Delta, will be contained in future documents for the SLWRI.

Shasta Dam and Reservoir Project

This section describes existing conditions for Shasta Dam and Reservoir water control facilities, recreation facilities, and other reservoir area infrastructure.

Existing Water Control Facilities

Shasta Dam is a curved, gravity-type, concrete structure that rises 533 feet above the streambed with a total height above the foundation of 602 feet. The dam has a crest width of about 41 feet and a length of 3,460 feet. Shasta Lake has a storage capacity and water surface area at gross pool of 4,550,000 acre-feet and 29,600 acres, respectively. Seasonal flood control storage space in Shasta is 1.3 MAF. The Shasta Powerplant consists of five main generating units and two station service units with a combined capacity of 652,000 kilowatts. **Table III-1** summarizes the pertinent data and features of Shasta Dam and Reservoir. **Plates 4** and **5** show several elevation, section, and plan views of Shasta Dam and Powerplant. These drawings were prepared prior to construction of the existing temperature control facilities on the upstream face of the dam. **Plate 6** shows the relationship between reservoir surface area and storage capacity at various water surface elevations.

Keswick Dam is about 9 miles downstream from Shasta Dam and, in addition to regulating outflow from the dam, controls runoff from 45 square miles of drainage area. Keswick Dam is a concrete, gravity-type structure with a spillway over the center of the dam. The spillway has four 50-foot by 50-foot fixed wheel gates with a combined discharge capacity of 248,000 cfs at full or gross pool elevation (587 feet). Storage capacity below the top of the spillway gates at gross pool is 23,800 acre-feet. The powerplant has a nameplate generating capacity of 75,000 kilowatts and can pass about 15,000 cfs at gross pool.

TABLE III-1
PERTINENT DATA – SHASTA DAM AND RESERVOIR AND KESWICK DAM AND RESERVOIR

GENERAL			
Drainage Areas (excluding Goose Lake Basin)		**Mean Annual Runoff (1908-1974)**	
Sacramento R. at Shasta Dam	6,421 sq-mi	Sacramento R. at Shasta Dam	5,737,000 ac-ft
Sacramento R. at Keswick	6,468 sq-mi	Sacramento R. near Red Bluff	8,421,000 ac-ft
Sacramento R. near Red Bluff	8,900 sq-mi	Sacramento R. at Ord Ferry	9,812,000 ac-ft
Sacramento R. near Ord Ferry	12,250 sq-mi	***Sacramento River Maximum Flows of Record (1903-1976)***	
Pit R. at Big Bend	4,710 sq-mi	at Shasta Lake (16 Jan 1974)	216,000 cfs
McCloud R. above Shasta Lake	604 sq-mi	near Red Bluff (28 Feb 1940)	291,000 cfs
Sacramento R. at Delta	425 sq-mi	at Ord Ferry (28 Feb 1940)	370,000 cfs
SHASTA DAM AND RESERVOIR			
Shasta Dam (concrete gravity)		**Shasta Reservoir**	
Crest elevation	1,077.5 ft	Gross pool elevation (msl)	1,067.0 ft
Freeboard above gross pool	9.5 ft	Minimum operating level	840.0 ft
Height above foundations	602 ft	Taking line	Irregular
Height above streambed	487 ft	Area	
Length of crest	3500 ft	Minimum operating level	6,700 acres
Width of crest	30 ft	Gross pool	29,500 acres
Slope, upstream	Vertical	Taking line	90,000 acres
Slope, downstream	1 on 0.8	Storage capacity	
Volume (cubic yards)	8,430,000	Minimum operating level	587,000 ac-ft
Normal tailwater elevation	585 ft	Gross pool	4,552,000 ac-ft
Spillway (gated ogee)		**Shasta Power Plant**	
Crest Length		***Main Units***	
Gross	360 ft	5 turbines, Francis type	
Net	330 ft	Total Capacity	515,000 hp
Crest Gates (drum type)		5 generators, 125,000 kW each	
Number and size	3 @ 110' x 28'	Total Capacity	625,000 kW
Top elevation when lowered	1037.0 ft	***Station Units***	
Top elevation when raised	1065.0 ft	2 generators, 2,000 kW each	
Discharge capacity at pool, elevation 1,065	186,000 cfs	Total Capacity	4,000 kw
Flashboard Gates	3 @ 110' x 2'	Elevation centerline turbines	586 ft
Top elevation when lowered	1067.0 ft	Maximum tailwater elevation	632.5 ft
Bottom elevation when raised	1069.5 ft	Total discharge capacity at pool, elevation 1,065	14,500 cfs
Outlets			
River outlets (102-inch diameter conduit with 96-inch diameter wheel type gate)		Total discharge capacity at pool, elevation 827.7	16,000 cfs
4 with invert elevation	737.75 ft		
8 with invert elevation	837.75 ft		
6 with invert elevation	937.75 ft		
Capacity at elevation 1,065	81,800 cfs		
Capacity at elevation 827.7	12,200 cfs		
Power outlets (15-ft steel penstocks)			
5 with invert elev. of intake	807.5 ft		
KESWICK DAM and RESERVOIR			
Keswick Dam (concrete gravity)		**Keswick Reservoir**	
Crest elevation	595.5 ft	Elevation msl	
Freeboard above maximum operating level	8.5 ft	Maximum operating level	587.0 ft
Height of dam above foundation	159 ft	Minimum operating level	574.0 ft
Height of dam above streambed	119 ft	Area at max operating level	643 acres
Length of crest	1,046 ft	*Storage capacity*	
Width of crest	20 ft	At maximum operating level	23,800 ac-ft
Volume	197,000 cu-yd	At minimum operating level	16,300 ac-ft
Normal tailwater elevation	487 ft	***Keswick Power Plant***	
Spillway (gated ogee)		Generator capacity, 3 units	75,000 kW
Crest length	200 ft		
Crest gates (fixed wheel)	4 @ 50' x 50'		
Discharge capacity at pool, elevation 587	248,000 cfs		

Key: ac-ft – acre feet; cfs – cubic feet per second; cu-yd – cubic yard; elevation – elevation in feet above msl; ft – feet; hp – horsepower; kW – kilowatt; msl – mean sea level; R. – river; sq-mi – square mile

The existing TCD at Shasta was constructed from 1996 to 1998. It is a multilevel water intake structure located on the upstream face of the dam, as shown in **Figure III-I**. The TCD allows operators to draw water from the top of the reservoir during the winter and spring when surface water temperatures are cool, and from deeper in the reservoir in the summer and fall when surface water is warm. It also improves oxygen and sediment levels in downstream river water. The TCD helps Reclamation fulfill contractual obligations for both water delivery and power generation while benefiting fish, such as salmon, that require cooler water temperatures.

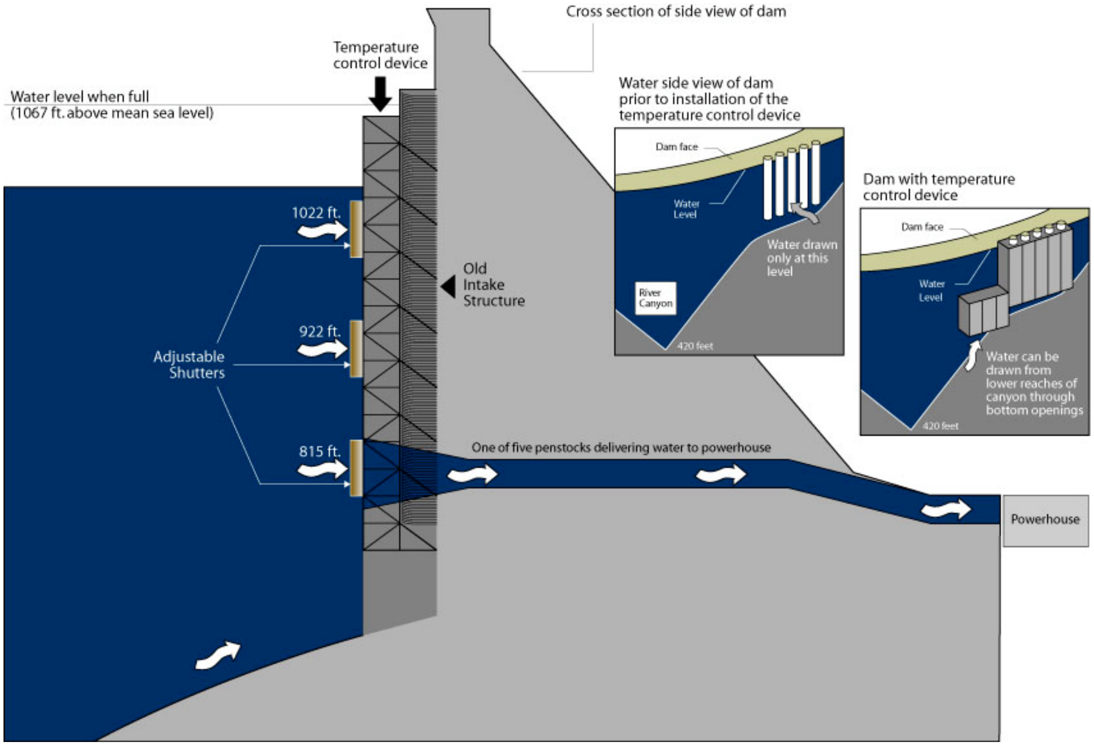


Figure III-1 – Shasta Dam temperature control device.

Recreation Facilities and Other Reservoir Area Infrastructure

The Whiskeytown-Shasta-Trinity National Recreation Area was established by an Act of Congress in November 1965. The area comprises three separate units: Whiskeytown Lake, Shasta Lake, and Clair Engle-Lewiston lakes. The Shasta Unit and the Clair Engle-Lewiston Unit are within the STNF and are administered by USFS. The Whiskeytown Unit is administered by the National Park Service. Facilities provided by USFS at Shasta Lake include 29 campgrounds, 4 boat-launching ramps, and 2 beach and picnic areas. In addition to USFS facilities, about 18 resorts and marinas are operating under permit within the Shasta Lake Unit. Facilities provided by these permit-holders include rental housing, stores, snack bars, restaurants, excursion boats, boat-dock service and rental, camping areas, and boat-launching ramps. A map showing locations of the major recreation facilities in the Shasta Unit of the Whiskeytown-Shasta Trinity National Recreation Area is shown in **Plate 7**.

Various recreation facilities and other infrastructure are located around the reservoir rim. An inventory of structures between the existing gross pool and 1,100 feet above mean sea level (msl) (elevation 1,100), a distance of about 30 feet, was conducted. About one-third of the total number of structures in the Shasta Reservoir vicinity (and nearly all of the recreation-related structures) is located within this 30-foot pool elevation band. At least one-fourth of the buildings within this band are homes or cabins, more than one-third are associated with private resorts or marinas, and an estimated 10 percent are associated with USFS facilities such as campgrounds, boat ramps, and stations. Some businesses and community buildings in the community of Lakeshore also may be located within 30 feet of the existing gross pool. Of the almost 30 campgrounds, half are either shoreline campsites or boat camps with no significant infrastructure. Portions of developed campgrounds, however, are located within 30 feet of the existing gross pool. Other significant infrastructure in the reservoir area includes vehicular and railroad bridges. Of the 22 bridges in the reservoir area, 10 carry the UPRR; 2 of the bridges are on Interstate 5 (I-5); 1 of the bridges (Pit River Bridge) carries both I-5 and UPRR; 3 of the bridges are maintained by Shasta County; and 6 of the bridges are maintained by USFS.

The most significant infrastructure between the existing gross pool and elevation 1,100 (i.e., within 30 feet of the existing gross pool, summarized in **Table III-2**) includes the following:

- Pit River Bridge (I-5 and UPRR)
- UPRR between Tunnels 1 and 2 (0.6 miles south of the Pit River Bridge)
- I-5 Bridge over the Sacramento River in the Lakeshore/Antlers area (and approximately 2,000 feet of I-5 at Lakeshore, just north of the bridge)
- Several homes in the communities of Lakeshore and Sugarloaf
- Pit 7 Dam (owned by PG&E)

TABLE III-2
SUMMARY OF AREA FACILITIES FROM EXISTING GROSS POOL TO ELEVATION 1,100

Facilities	Number
Buildings	197
Bridges	22
Dams	2
Paved road segments	86
Unpaved road segments	53
Parking areas	16
Railroad segments (not including railroad bridges)	1
Power towers	3
Other infrastructure	23
Total Items	**403**

Source: Shasta Reservoir Area Inventory, February 2002.

Plate 8 shows a plan and profile view of the Pit River Bridge. The Pit River Bridge is the most significant structure within the inventory range.

Physical Environment

Elements of the physical environment surrounding Shasta Dam and Reservoir described in this section include topography, geology, soils, geomorphology, sedimentation and erosion, climate and hydrology, flood control, water quality, air quality, and noise.

Topography

Shasta Dam and Reservoir are located on the northern edge of California's Central Valley, which is almost completely enclosed by mountains and has only one outlet, through San Francisco Bay to the Pacific Ocean. The valley is nearly 500 miles long and averages 120 miles in width. The Central Valley is drained by the Sacramento River in the northern portion and the San Joaquin River and Tulare Lake tributaries in the southern portion.

The major tributary drainages above Shasta Dam, the Sacramento, McCloud, and Pit rivers, and several smaller drainages, originate in the east and flow generally westward into Shasta Lake. Downstream from the dam, the Sacramento River travels south to the Delta, picking up additional flows from numerous tributaries, including Cottonwood Creek, Stony Creek, the Feather and American rivers, and others. The Sacramento River basin covers approximately 27,000 square miles and is about 240 miles long and up to 150 miles wide.

Ground surface elevations in the northern portion of the Sacramento Valley range from above 14,000 feet at Mount Shasta in the headwaters of the Sacramento River to approximately 1,070 feet at Shasta Lake. About 65 percent of the mountainous area within this range lies below 4,000 feet in elevation and 97 percent below 7,000 feet in elevation. Other mountain areas bordering the valley reach elevations higher than 10,000 feet. In the southern portion of the Sacrament River basin, the Sacramento Valley floor is relatively flat.

Geology

The geology of the study area is highly complex, containing portions of five geomorphic provinces: the Coast Range, Klamath Mountains, Great Valley, Cascade Range, and Modoc Plateau.

Shasta Lake is located within the Klamath Mountain geomorphic province at the north end of the Sacramento Valley. The Klamath Mountain province is considered to be a northern extension of the Sierra Nevada and consists of rugged topography with prominent peaks and ridges. The drainage of this province is primarily through the Klamath and the upper Sacramento rivers.

Geology of the Klamath Mountains to the north and west of the study area, including Shasta Lake and its tributaries, comprises older bedrock materials, sedimentary basin deposits, and volcanic deposits, and includes the Bully Hill Rhyolite, Pit, Hosselkus Limestone, Balaklala Rhyolite, Kennett, and Bragdon formations. The Balaklala Rhyolite group of rhyolitic flows, pyrite, and other pyroclastic rocks were the primary source of base-metal ore bodies that supported copper, zinc, gold, and silver mining operations in the subarea. Other geologic formations include Mesozoic formations of sedimentary and volcanic fragments that contain mudstone, shale, sandstone, and conglomerate, and pre-Cretaceous metamorphic, abundant serpentine and granitics. Volcanic components typically arise in the east from the Klamath

Mountain Belt and include basalt, andesite, breccia, agglomerate, and tuff. Alluvial deposits overlay a large portion of this area.

The McCloud limestone formation, in the northeastern portion of the area around Shasta Lake and its tributaries, is a unique feature of the study area. This formation is of paleontological significance because it is composed primarily of coral reefs and other marine formations that hold the fossilized remains of a diverse group of fauna. Paleontological findings and information from the McCloud limestone have provided the basis for current scientific knowledge of invertebrate and vertebrate development in California. Today, limestone caves also provide unique habitat for several cave-dwelling species in the subarea, including the Shasta salamander, Shasta eupatorium, Howell’s cliff-maids, and Shasta snow-wreath.

The portion of the study area along the Sacramento River downstream to the RBDD encompasses portions of the Cascade Range, Klamath Mountains, and Great Valley geomorphic provinces. The Cascade Range to the east comprises primarily volcanic formations and volcanic sedimentary deposits, including the Tuscan Formation and Montgomery Creek Formation. The Central Valley province (also referred to as the Great Valley) is a large, asymmetrical, northwestwardly trending, structural trough formed between the uplands of the California Coast Ranges to the west and the Sierra Nevada to the east. This trough has been filled with a tremendously thick sequence of sediments ranging in age from Jurassic to Recent.

Principal formations include the Tehama, Riverbank, Chico, and Red Bluff formations, which contain marine and nonmarine sedimentary rocks eroded from the surrounding Cascade Range and Klamath Mountains. These fluvial formations comprise silt, sand, clay, and gravel.

Soils

Soils in the Sacramento River basin are divided into four physiographic groups: upland soils, terrace soils, valley land soils, and valley basin soils. Upland soils are prevalent in the hills and mountains of the region and are composed mainly of sedimentary sandstones, shales, and conglomerates of igneous rocks. Terrace and upland soils are predominant between Redding and Red Bluff; however, valley land soils border the Sacramento River through this area. Valley land and valley basin land soils occupy most of the Sacramento Valley floor south of Red Bluff. Valley land soils consist of deep alluvial and aeolian soils that make up some of the best agricultural land in the State. The valley floor was once covered by an inland sea and sediments were formed by deposits of marine silt followed by mild uplifting earth movements. After the main body of water disappeared, the Sacramento River began eroding and redepositing silt and sand in new alluvial fans.

Geomorphology

The geomorphology of the Sacramento River is a product of several factors: the geology of the Sacramento Valley, hydrology and climate, vegetation, and human activity. Large flood events drive lateral channel migration and remove large flow impediments. Riparian vegetation stabilizes riverbanks and reduces water velocities, inducing deposition of eroded sediment. In the past, a balance existed between erosion and deposition along the Sacramento River. However, construction of dams, levees, and water projects has altered stream flow and other hydraulic characteristics of the Sacramento River. In some areas, human-induced changes have stabilized and contained the river, while in other reaches the loss of riparian vegetation has reduced sediment deposition and led to increased erosion.

The upper Sacramento River between Shasta Lake and Red Bluff is bounded and underlain by resistant volcanic and sedimentary deposits that confine the river, resulting in a relatively stable river course. This reach of river is characterized by steep vertical banks and the river is primarily confined to its channel with limited overbank floodplain areas. There is limited meander of the river above Red Bluff. Downstream from Red Bluff, the Sacramento River is active and sinuous, meandering across alluvial deposits within a wide meander belt. Geologic outcroppings and man-made structures, such as bridges and levees, act as local hydraulic controls along the river. Bank protection, consisting primarily of rock riprap, has been placed along various sections of the Sacramento River to prevent erosion and river meandering.

Sedimentation and Erosion

Sedimentation and erosion are natural processes throughout the primary and extended study areas. These processes have been affected by a number of factors, including logging, hydraulic mining; construction of dams and roads, reservoirs, and channel modifications; and agricultural and urban activities. Sedimentation and erosion in the basin also have been significantly accelerated at times following large forest fires. It is difficult for forests to recover from severe wildfires, which can cause increased erosion and sediment input into streams. Subsequent changes in stream morphology often have resulted in degraded aquatic habitat and loss of adjacent wetland areas.

The watershed above Shasta Lake is generally well forested and erosion is not excessive. Many of the tributaries of Shasta Lake are well-balanced stream systems, where flows, sediment bedload, and the delivery of large woody debris are in dynamic equilibrium. This equilibrium contributes to the formation and maintenance of favorable fisheries habitat, including pools, riffles, complex woody structures, and desirable spawning areas within the tributaries.

However, as much of the terrain is steep, landslides are relatively common and range from small mudflows and slumps to large debris slides, debris flows, or landslides. Slides and sheet wash typically supply debris and sediments to the tributary streams of Shasta Lake during the rainy season. Volcanic eruptions and mudflows have periodically affected channel morphology, often changing habitat conditions in area streams. The most active volcanic feature in the area around Shasta Lake is Mount Shasta, which is estimated to have erupted 13 times in the last 10,000 years. The last major mudflow, which occurred on Mud Creek in 1924, sent sediment down the McCloud River that was observed as far downstream as San Francisco Bay.

Shasta and Keswick dams affect sediment transport because they block sediments that would normally have been transported from the upper Sacramento River basin. The result has been a net loss of coarse sediment in the Sacramento River below Keswick Dam that has negatively impacted spawning gravels. In alluvial river sections, bank erosion and sediment deposition cause migrations of the river channel that are extremely important in maintaining instream and riparian habitats, but also can cause loss of agricultural lands and damage to roads and other structures. In the Sacramento River, these processes are most important in the major alluvial section of the river, which begins downstream from the RBDD. The river channel in the Keswick to RBDD reach is more constrained by erosion-resistant volcanic and sedimentary formations and therefore is more stable.

The problem of gravel availability in the Sacramento River is exacerbated downstream from Keswick Dam by dams constructed on Sacramento River tributaries, bank protection measures along the mainstem of the Sacramento River, and instream gravel mining. In the recent past, Reclamation, DWR, and CDFG have cooperated in actions to artificially replenish salmon spawning gravel in the reach.

Along the tributaries, human-induced impacts to river morphology include livestock grazing, urbanization and related infrastructure construction, riparian vegetation removal, gravel mining, bank protection, dams, and water diversions. Over time, the major tributary streams developed multiple terraces adjacent to the stream channels. Some also have developed small fan deposits of gravels at their mouths, but large fans are more typical of the tributaries downstream from Red Bluff. Some tributaries, such as Cottonwood Creek, also include deposits of mine tailings, either washed downstream from mining in the mountains or left by floating dredges. Eastside streams tend to produce less gravel because they drain steep, resistant volcanic terrain. Westside streams produce the majority of gravel entering the Sacramento River because they flow through gravelly alluvial deposits subject to tectonic uplift. Sediment and gravel discharge changes from year to year depending on hydrology and conditions in the watersheds, such as fires, mass wasting, timber harvesting, road construction, and changing land uses.

Climate and Hydrology

The Sacramento River basin contains the entire drainage area of the Sacramento River and its tributaries and extends almost 300 miles from Collinsville in the Delta north to the Oregon border. Hot, dry summers, with temperatures that can exceed 100 degrees Fahrenheit, and mild winters characterize the valley floor. Average temperatures range from about 60 degrees Fahrenheit in low valley regions to about 40 degrees in mountain areas.

Total annual precipitation at higher elevations averages between 60 and 70 inches and is as much as 95 inches in the northern Sierra Nevada and the Cascade Range, where snow typically accumulates above 4,000 to 5,000 feet in elevation. Precipitation on the valley floor occurs mostly as rain, and yearly totals range from 20 inches in the northern end of the valley to about 15 inches at the Delta. Average annual precipitation throughout the Sacramento River basin is 36 inches.

Hydrologic features of the study area include perennial, intermittent, and ephemeral stream channels, and natural water bodies and wet meadowlands. Major floods are typically a result of rain-on-snow events that result in a rapid melting of the winter snowpack. Eastside tributaries to the Sacramento River typically originate in the Cascade Range and include Stillwater, Cow, Bear, Battle, and Paynes creeks. Perennial and intermittent westside tributaries originate in the Klamath Mountains or foothills, and include Clear and Cottonwood creeks.

The most intensive runoff occurs in the upper watershed of the Sacramento River above Shasta Lake and on the rivers originating on the west slope of the Sierra Nevada. These watersheds produce an annual average of 1,000 to more than 2,000 acre-feet of runoff per square mile.

The Sacramento River contributes the majority water to Delta inflow. Unimpaired flow from the four major rivers in the Sacramento River basin (Sacramento, Feather, Yuba, and American rivers) averaged 21.2 MAF and ranged from about 5 to 38 MAF during the 1906-1996 period. Of this flow, the Sacramento River (at Red Bluff) averaged 8.4 MAF (including Trinity River imports, described below), the Feather River averaged 4.5 MAF, the Yuba River averaged 2.4 MAF, and the American River averaged 2.6 MAF.

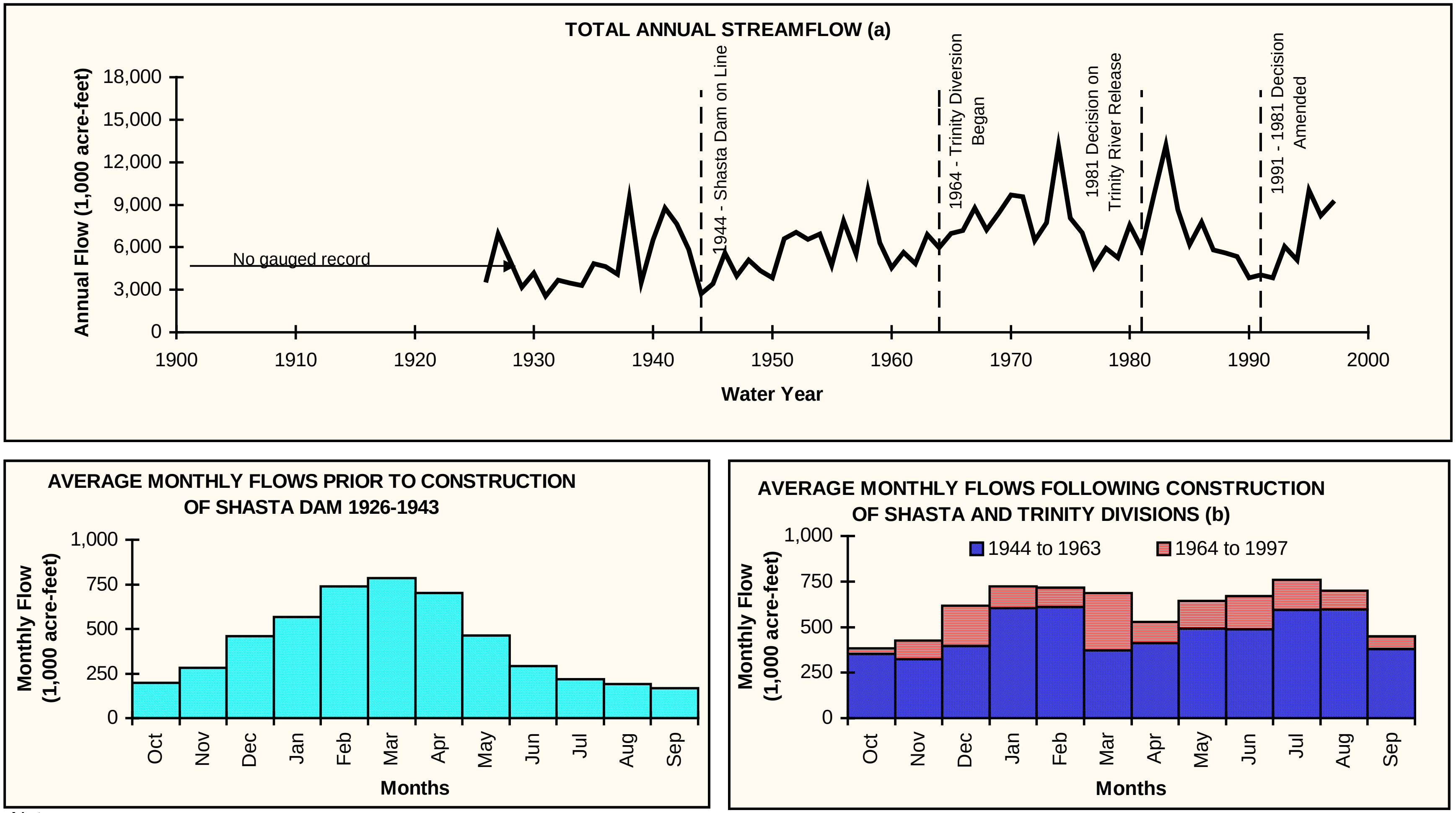
Mean monthly inflow, outflow, and storage at Shasta Reservoir are shown in **Table III-3**. The highest average monthly inflow period for Shasta is January through March. Winter and early spring inflows are stored for later release during the summer irrigation season.

Since 1964, a portion of the flow from the Trinity River basin has been exported to the Sacramento River basin through CVP facilities, as shown in **Figure III-2**. Historically, an average annual quantity of 1.27 MAF of water has been exported. This annual quantity is approximately 17 percent of the flows measured in the Sacramento River at Keswick Dam. However, Trinity River diversions to the Sacramento River are to be reduced as part of the December 2002 ROD to allow more inflows to remain in the Trinity River for fish restoration purposes.

TABLE III-3
MEAN MONTHLY INFLOW TO SHASTA RESERVOIR

Month	Inflow [1] (1,000 acre-feet)	Outflow [2] (1,000 acre-feet)	Shasta Storage [3] (1,000 acre-feet)
January	799	587	3,131
February	836	628	3,355
March	889	511	3,719
April	693	421	3,961
May	537	524	3,948
June	339	536	3,720
July	247	615	3,326
August	223	571	2,966
September	220	377	2,809
October	263	301	2,775
November	365	331	2,801
December	585	465	2,906
Total	**5,991**	**5,868**	**-**
Average	**499**	**489**	**3,285**

Notes:
[1]Computed data based on a period from 1944 to 2002.
[2]Recorded data based on a period from 1944 to 2002.
[3]Shasta storage data computed based on a period from 1953 to 2002.



Notes:
(a) First full year of stream flow data for station 11370500 was 1939. Data for 1926-1963 are from Station 1136950.
(b) Upper portion of bar represents incremental increase in average monthly flows since 1964 water year, due to releases through the Spring Creek Powerplant.

Figure III-2 – Historical streamflow in the Sacramento River below Keswick Dam.

Flood Control

A number of flood management projects along the Sacramento River affect the flow and operation of facilities, including dams and reservoirs, levees, and weirs. Major reservoirs in the Sacramento River watershed and flood control storage space include Folsom Reservoir on the American River, Lake Oroville on the Feather River, Black Butte Reservoir on Stony Creek, and Shasta Reservoir. Other major flood management system facilities include five weirs, located along the Sacramento River, to divert part of flood flows to overflow basins and bypasses (Butte Basin, Sutter Bypass, and Yolo Bypass). The weirs allow high Sacramento River flow to enter the basin and bypass the system. Weirs were designed to begin operation in a certain order: Tisdale Weir, Colusa Weir, Fremont Weir, Moulton Weir, and Sacramento Weir.

The flood management system of the San Joaquin River basin includes levees along the lower portions of Ash and Berenda sloughs; Bear Creek; Fresno and Stanislaus rivers; and levied sections along the San Joaquin River. The Chowchilla Canal Bypass diverts San Joaquin River flow excess and sends it to the Eastside Bypass. In addition to the Chowchilla Canal Bypass, the Eastside Bypass intercepts flows from minor tributaries and rejoins the San Joaquin River between Fremont Ford and Bear Creek. The San Joaquin River levee and diversion system is not designed to contain the objective release from each project reservoir simultaneously.

The primary non-Federal sponsor for flood control projects in both the Sacramento River and San Joaquin River basins is the Reclamation Board of the State of California. The Reclamation Board has signed onto the assurances of operating and maintaining the Federal project under the authority of the Flood Control Act of 1944. The Reclamation Board has local agreements with DWR, levee districts, reclamation districts, and other entities. These local agreements document shared operation and maintenance requirements with the Reclamation Board. Because reclamation districts and other local entities perform the actual maintenance and operation for sections of the flood control project, maintenance practices vary from almost no maintenance to outstanding maintenance. The quality of maintenance normally depends on the funding availability to the maintaining entity; funding availability varies widely.

Maintaining flood management system levees and channels is difficult due to the erosive nature of the flood flows that the current system configuration produces, and due to expensive environmental mitigation when bank protection is required. The system is tightly leveed in many locations and the levees must be continually protected from erosion. The most common material used is rock riprap, which effectively prevents erosion but negatively impacts riparian habitat. Mitigation costs for new flood control projects and improvements have constantly increased over the past decades due to environmental awareness.

Prior to construction of Shasta Dam, the Sacramento River typically experienced large fluctuations in flow driven by winter storms, with late-summer flows averaging 3,000 cfs or less. These fluctuations and periodic floods moved large amounts of sediment and gravel out of the mountainous tributaries and down the Sacramento River. Completion of Shasta Dam in 1945 resulted in a general dampening of historic high and low flows, reducing the magnitude of winter floods while maintaining higher summer flows between 7,000 and 13,000 cfs.

The current regulation of Shasta Dam for flood control requires that releases be restricted to quantities that will not cause downstream flows or stages to exceed, insofar as possible, (1) a flow of 79,000 cfs at the tailwater of Keswick Dam and (2) a stage of 39.2 feet at the Sacramento River at Bend Bridge gaging station near Red Bluff (corresponding roughly to a flow of 100,000 cfs). **Plates 9 and 10** show peak flow-frequency relationships at both Keswick and Bend Bridge. A storage space of up to 1.3 MAF below gross pool elevation of 1,067 is also kept available for flood control purposes in the reservoir in accordance with the Flood Control Diagram (see **Plate 11**), as prescribed by the Corps. Under the diagram, flood control storage space increases from zero on October 1 to 1.3 MAF (elevation 1,018.55) on December 1 and is maintained until December 23. From December 23 to June 15, the required flood control space varies according to parameters based on the accumulation of seasonal inflow. This variable space allows for the storage of water for conservation purposes, unless it is required for flood control based on basin wetness parameters and the level of seasonal inflow. Daily flood control operation consists of determining the required flood storage space reservation and scheduling releases in accordance with flood operating criteria.

Flood control operations of Shasta Dam require forecasting of flood runoff both above and below the dam. Rapidly changing inflows are continually monitored, and the forecasts of the various inflows are adjusted as required. The time of streamflow travel from Shasta Dam to Bend Bridge is about 9 to 10 hours under higher flow conditions. The timing of peak reservoir inflows and peak inflows from tributaries downstream from the dam can complicate release operations. The large size of the flood control pool at Shasta Reservoir can prolong flood release operations for many weeks as operators vacate the pool before the next storm event.

As indicated, a goal of the existing operation is to have an excess of the required flood control space vacant in the flood season and then fill the pool to the maximum extent possible for water supply and other needs in the remainder of the year. **Plate 12** is a plot showing the historical monthly storage in Shasta Reservoir for the period of 1953 through 2002. In most years, Shasta Reservoir has been able to fill following the flood season drawdown.

Releases from Shasta Dam are often made for flood control. **Table III-4** shows the historical annual inflow, storage, and outflow history for Shasta Reservoir from 1945 through 2002. Releases for flood control can either occur in the fall to reach the prescribed vacant flood space beginning in early October, or to evacuate space during or after a storm event to maintain the prescribed vacant flood space in the reservoir. During a storm event, releases for flood control can occur either over the spillway during large events or through river outlets for smaller events. As shown in **Table III-4**, from about 1950 through 2002, flows over the spillway occurred in 12 years, or in 23 percent of post-1950 years. It is estimated that releases for flood control (either for seasonal space evacuation or during a flood event, and including spills over the spillway) occurred in about 37 years, or nearly 70 percent of the years.

The estimated frequency (percent exceedance) of storage in Shasta Reservoir for the end of September, based on the SLWRI CALSIM II benchmark simulation, is shown in **Figure III-3**. The average storage in the reservoir (50 percent exceedance) under existing conditions prior to the beginning of flood control operations is about 2.7 MAF. The frequency distribution graph also shows that in about 80 percent of the years, the end of September stage is greater than about 1.9 MAF, and 3.3 MAF in approximately 20 percent of the years.

TABLE III-4
SHASTA DAM AND RESERVOIR FLOOD CONTROL RELEASES

Water Year	Total Inflow (TAF)	End of Sept. Storage (TAF)	Outflows (TAF)				Water Year	Total Inflow (TAF)	End of Sept. Storage (TAF)	Outflows (TAF)			
			Total	Power-Plant	Spill-way	Outlets				Total	Power Plant	Spill-way	Outlets
1945	4,858		3,462	2,624		839	1974	10,796	3,658	10,364	6,796		3,568
1946	5,906		5,599	3,898		1,700	1975	6,405	3,570	6,384	6,153		231
1947	3,908		3,964	3,571		393	1976	3,611	1,295	5,813	5,813		
1948	5,416		4,958	4,244		714	1977	2,628	631	3,247	3,247		
1949	4,318		4,303	4,303		0	1978	7,837	3,428	4,944	4,538		407
1950	4,133		3,784	3,781	1	2	1979	4,022	3,141	4,203	4,203		
1951	6,316		6,486	5,696		790	1980	6,415	3,321	6,139	4,773		1,366
1952	7,785		6,800	5,625	9	1,166	1981	4,103	2,480	4,845	4,845		
1953	6,540	3,300	6,408	5,067		1,341	1982	9,013	3,486	7,910	6,464	253	1,193
1954	6,541	3,059	6,826	5,941		885	1983	10,794	3,617	10,576	7,123	1	3,452
1955	4,112	2,455	4,612	4,612			1984	6,667	3,240	6,944	6,514		429
1956	8,834	3,569	7,606	4,926	12	2,668	1985	3,971	1,978	5,154	5,152	2	
1957	5,368	3,485	5,341	4,841	17	483	1986	7,546	3,211	6,225	4,383		1,842
1958	9,698	3,473	9,610	6,672	13	2,924	1987	3,944	2,108	4,957	4,800		157
1959	5,086	2,504	5,952	5,631		321	1988	3,931	1,586	4,368	3,973		395
1960	4,733	2,756	4,380	4,380			1989	4,745	2,096	4,154	3,951		203
1961	5,071	2,333	5,402	5,402			1990	3,616	1,637	3,999	3,707		292
1962	5,262	2,908	4,582	4,582			1991	3,051	1,340	3,286	2,666		620
1963	7,003	3,242	6,575	6,077	13	485	1992	3,622	1,683	3,204	1,755		1,449
1964	3,905	2,202	4,849	4,849			1993	6,825	3,102	5,316	3,728		1,588
1965	6,983	3,612	5,475	4,581		894	1994	3,087	2,102	4,002	3,252		750
1966	5,299	3,263	5,544	5,544			1995	9,638	3,136	8,511	5,187		3,324
1967	7,404	3,506	7,066	6,131		935	1996	6,846	3,089	6,781	3,703		3,078
1968	4,772	2,670	5,515	5,138		377	1997	7,424	2,308	8,106	5,808		2,298
1969	7,668	3,528	6,714	5,421		1,293	1998	10,294	3,441	9,072	6,698	2	2,372
1970	7,902	3,440	7,885	5,477	4	2,404	1999	7,196	3,328	7,202	6,379		824
1971	7,328	3,275	7,402	6,824	1	578	2000	6,839	2,985	7,074	5,573		1,501
1972	5,078	3,267	5,000	5,000			2001	4,141	2,200	4,824	4,823		1
1973	6,167	3,317	6,026	5,583		443	2002	5,052	2,558	4,590	4,590		
						Average		**5,991**	**2,818**	**5,868**	**4,949**	**6**	**913**

Key:
TAF – thousand acre-feet

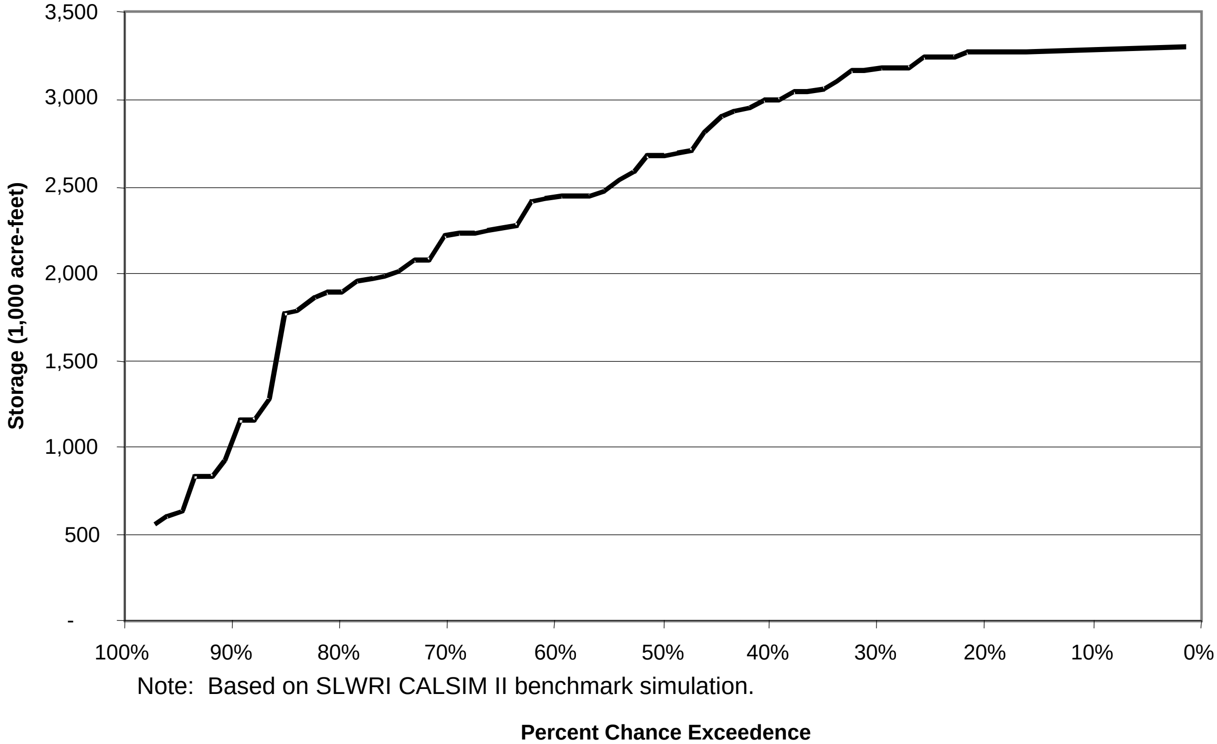


Figure III-3 – Estimated frequency (percent chance exceedence) of storage at the end of September in Shasta Reservoir with 2000 level demands and D-1641 requirements.

The estimated safe channel carrying capacity of the Sacramento River downstream from Keswick through Redding is 79,000 cfs. Shasta Dam and Reservoir can control outflows from Keswick to that value from about a 1.3 chance in 100 to 1.0 chance in 100 in any one year (see **Plate 9**) if it is operated precisely according to the Flood Control Manual. For flood events rarer than about the 1.0 chance in 100 in any one year, inflows to Shasta would exceed the ability of the reservoir to store the inflow volume and maintain the 79,000 cfs channel capacity. Under these circumstances, outflows from the dam would need to be increased to prevent uncontrolled conditions (see **Plate 9**).

Shasta Lake collects flow in the upper Sacramento River watershed, but many uncontrolled tributaries enter the Sacramento River downstream from the dam. Stream gages have been added to major uncontrolled tributaries entering downstream from Shasta Lake (Cow, Battle, Cottonwood, and Thomes creeks). To a limited extent, the operators of Shasta Dam can adjust releases containing these uncontrolled flows to try to reduce downstream peak flows. Accordingly, the influence of Shasta's operation on reducing peak flood flows diminishes downstream on the Sacramento River.

Water Quality

The SWRCB and RWQCBs largely determine objectives for water quality in California's surface waters. The study area lies entirely within the region under jurisdiction of the Central Valley Regional Water Quality Control Board (CVRWQCB). Water quality objectives for a particular reservoir or river reach are affected by its beneficial uses, which are determined by CVRWQCB.

Water quality must adequately protect beneficial uses. Beneficial uses for Shasta Lake and its tributaries, and the reach of the Sacramento River between Shasta Dam and the Colusa Basin Drain (which includes Keswick Reservoir and the river between Keswick Dam and the Colusa Basin Drain), are provided in **Table III-5**.

Water quality in the study area generally supports the beneficial uses of area rivers and reservoirs. However, impaired water quality conditions have been found for specific waters of the study area in the recent past and some of these impaired conditions persist. Principal water quality issues in the study area include water temperatures in the Sacramento River between Keswick Dam and the RBDD, turbidity in Shasta Lake, and acid mine drainage and associated heavy metal contamination from the Spring Creek drainage and other abandoned mining sites. Elevated pesticide levels have been found at some sites in the Sacramento River Valley for a number of years, but these sites are downstream from Red Bluff. Stormwater runoff from Redding and other urban areas likely flushes contaminants into the Sacramento River, but the volume of flow in the river generally provides sufficient dilution to prevent excessive concentrations in the river. The City of Redding is working toward compliance under Phase II of the National Pollution Discharge Elimination System (NPDES).

TABLE III-5
BENEFICIAL USES FOR SURFACE WATERS IN THE STUDY AREA

Beneficial Use	Pit River - Hat Creek to Shasta Lake	McCloud River	Sacramento River – Box Canyon Dam to Shasta Lake	Shasta Lake	Sacramento River - Shasta Dam to Colusa Basin Drain
Municipal & domestic supply (drinking water)	E	E		E	E
Agriculture, irrigation	E		E	E	E
Agriculture, stock watering	E		E		E
Industry, service supply					E
Industry, power	E	E		E	E
Recreation, contact	E	E	E	E	E
Recreation, whitewater	E	P	P		E
Recreation, noncontact	E	E	E	E	E
Freshwater habitat, warm	P			E	P
Freshwater habitat, cold	E	E	E	E	E
Migration, warm					E
Migration, cold					E
Spawning, warm	E			E	E
Spawning, cold	E	E	E	E	E
Wildlife habitat	E	E	E	E	E
Navigation					E

Key:
E – existing beneficial use
P – potential beneficial use

Air Quality

The northern half of the Central Valley is located in the Sacramento Valley Air Basin (SVAB). The Coast Range, Sierra Nevada Range, Cascade Mountains, and San Joaquin Valley basin bound the basin. Marine winds enter the valley at the Carquinez Straits and head eastward until deflected north into the Sacramento Valley and south into the San Joaquin Valley. A combination of air contaminants, meteorological conditions, and the topographic configuration of the valley affect air quality throughout the Sacramento Valley basin. Most of the air pollutants in the study area may be associated with either urban or agricultural land uses.

During the summer, Pacific high-pressure systems can create inversion layers in the lower elevations that prevent the vertical dispersion of air. As a result, air pollutants can become concentrated during the summer, lowering air quality. During the winter, when the Pacific high-pressure system moves south, stormy, rainy weather intermittently dominates the region. Prevailing winter winds from the southeast disperse pollutants, often resulting in clear, sunny weather and better air quality over most of the region. Much of the SVAB is designated as a nonattainment area with respect to the national and State ozone (O_3) and particulate matter (PM_{10}) standards, and the urban Sacramento and Maryville/Yuba City areas are designated as nonattainment for national and State carbon monoxide standards.

The relatively low residential density of Shasta County's rural and suburban areas contributes to an auto-dependent lifestyle that affects air quality. Pollution from mobile sources, such as cars and trucks, represents 43 percent of hydrocarbons emissions, 57 percent of nitrogen oxide (NO) emissions, 59 percent of reactive organic gases, and 82 percent of carbon monoxide emissions in typical urban areas of Shasta County (Shasta County General Plan). Many other sources of air pollution exist in the study area (e.g., residential, agricultural, and forest management burn practices, imported pollutants from lower Sacramento Valley, unpaved roads, etc.).

Noise

Noise levels in densely populated areas of the State are influenced predominantly by the presence of limited-access highways carrying extremely high volumes of traffic, particularly heavy trucks. Noise in rural areas where traffic generally is low to moderate is measured at considerably lower decibels. Noise at Shasta Lake is affected by the presence of boats and personal watercraft.

Biological Environment

Biological resources in the region result from a wealth and diversity of climatic and vegetative associations within and adjacent to the study area. Influences from the coastal mountains, southern Cascades, northern Sierra Nevada, Great Basin, and Central Valley provide for a unique mix of biota.

Much of the area, especially within the Central Valley, has been modified by past and present land uses. Prior to human settlement, this region was dominated by riparian vegetation within the annual floodplains, with stands of valley oak and interior live oak on higher ground. Herbaceous wetland bottoms and upland native grassland communities were common in this vegetation mosaic. The extensive oak forests and riparian/wetland habitats hosted a diverse and abundant wildlife community. Cattle grazing, deforestation of the oak woodlands, and flood protection resulting in expansion of agriculture onto the floodplains in the early to mid-1800s substantially altered both the floodplain and channel vegetation. Agriculture is currently the primary land use in the Central Valley, with riparian vegetation relegated to narrow strips along portions of the Sacramento and San Joaquin Rivers and their tributaries.

Aquatic and Fishery Resources

Table III-6 contains the common and scientific names of fish species found in the study area and their likely locations. Fish species assemblages of the Sacramento River include anadromous and resident salmonids and native warm water river species such as Sacramento sucker and Sacramento pike minnow.

The Shasta Lake and Keswick Reservoir fish species include mostly introduced warm water and cold water species. The Shasta Lake tributary species comprise planted and wild trout and several native species. Major nonfish aquatic animal species assemblages of the study area are the benthic macroinvertebrates of Shasta Lake, the Sacramento River, and tributaries to Shasta Lake, and the zooplankton of the reservoirs.

TABLE III-6
FISH SPECIES KNOWN TO OCCUR IN THE STUDY AREA

Common Name	Scientific Name	Shasta Lake Tributaries	Shasta Lake / Keswick Reservoir	Sacramento River - Keswick to Red Bluff
Chinook salmon	*Oncorhynchus tshawytscha*		X	
winter-run				X
spring-run				X
fall-run				X
late fall-run				X
Kokanee salmon	*Oncorhynchus nerka*	X	X	
Rainbow trout	*Oncorhynchus mykiss*	X	X	X
Steelhead trout	*Oncorhynchus mykiss*			X
Brown trout	*Salmo trutta*	X	X	
Green sturgeon	*Acipenser medirostris*			X
White sturgeon	*Acipenser transmontanus*	X	X	X
Pacific lamprey	*Lampetra tridentata*			X
Western brook lamprey	*Lampetra richardsoni*			X
Sacramento sucker	*Catostomus occidentalis*	X	X	X
Sacramento pikeminnow	*Ptychocheilus grandis*	X	X	X
Hardhead	*Mylopharodon conocephalus*	X	X	X
Sacramento blackfish	*Orthodon microlepidotus*	X	X	
California roach	*Hesperolecus symmetricus*	X		X
Speckled dace	*Rhinichthys osculus*	X	X	
Golden shiner	*Notemigonus crysoleucas*	X	X	
Carp	*Cyprinus carpio*	X	X	X
Channel catfish	*Ictalurus punctatus*	X	X	X
White catfish	*Ameiurus catus*		X	X
Brown bullhead	*Ameiurus nebulosus*		X	X
Black bullhead	*Ameiurus melas*		X	X
Riffle sculpin	*Cottus gulosus*	X	X	
Prickly sculpin	*Cottus asper*			X
Largemouth bass	*Micropterus salmoides*		X	
Smallmouth bass	*Micropterus dolomieui*	X	X	X
Spotted bass	*Micropterus punctulatus*	X	X	
Black crappie	*Pomoxis nigromaculatus*		X	
White crappie	*Pomoxis annulauris*		X	
Bluegill sunfish	*Lepomis macrochirus*		X	
Green sunfish	*Lepomis cyanellus*	X	X	
Threadfin shad	*Dorosoma petenense*		X	

Shasta Lake/Tributaries and Keswick Reservoir

The fisheries resources of Shasta Lake are greatly affected by the reservoir's thermal structure. During summer months, the epilimnion (warm surface layer) is 30 feet deep and up to 80 degrees Fahrenheit. Water temperatures above 68 degrees Fahrenheit favor warm water fishes such as bass and catfish. Deeper water layers, which include the hypolimnion and the metalimnion (transition zone between epilimnion and the hypolimnion), are colder and suitable for cold water species. Shasta Lake is classified as warm monomitic because it has one period of mixing per year.

The warm water fish habitats of Shasta Lake occupy two ecological zones: the littoral (shoreline/vegetated) and the pelagic (open water) zones. The littoral zone lies along the reservoir shoreline down to the maximum depth of light penetration on the reservoir bottom, and supports populations of spotted bass, smallmouth bass, largemouth bass, black crappie, bluegill, channel catfish, and other warm water species.

The upper, warm surface layer of the pelagic (open water) zone is the principal plankton-producing region of the reservoir. Plankton comprises the base of the food web for most of the reservoir's fish populations. Operation of the Shasta Dam TCD, which helps conserve the reservoir's cold water pool by accessing warmer water for storage releases in the spring and early summer, may reduce zooplankton biomass, which resides primarily in the reservoir's warmer surface water layer.

The deeper areas of Shasta Lake, hypolimnion and metalimnion, support cold water species such as rainbow and brown trout and landlocked chinook and kokanee salmon. Native species such as white sturgeon, Sacramento blackfish, hardhead minnow, riffle sculpin, Sacramento sucker, and Sacramento pikeminnow reside in cold water near the reservoir bottom. Trout may congregate near the mouths of the reservoir's tributaries, including the upper Sacramento River, McCloud River, Pit River, and Squaw Creek, when inflow temperatures of these streams are favorable.

The lower reaches of the reservoir's tributaries also provide spawning habitat for reservoir fish populations, and have important resident fisheries of their own (rainbow trout is the principal games species). Most native species found in the reservoir and listed previously also inhabit the lower reaches of the tributaries. One of the species, the hardhead minnow, is classified as a State of California Species of Special Concern. The McCloud River once supported a population of bull trout, which is currently a Federal and State listed species. A few creeks on the western shore of the reservoir are devoid of biological life due to toxic effluent from local mines.

Sacramento River

The Sacramento River flows for about 59 miles between Keswick Dam and the RBDD. The river in this reach has a stable, largely confined channel with little meander. Riffle habitat with gravel substrates and deep pool habitats are abundant in comparison with reaches downstream from RBDD. Immediately below Keswick Dam, the river is deeply incised in bedrock with very limited riparian vegetation and no functioning riparian ecosystems. Water temperatures are generally cool even in late summer due to regulated releases from Shasta Lake and Keswick Reservoir. Near Redding, the river comes into the valley and the floodplain broadens.

Historically, this area appears to have had wide expanses of riparian forests, but much of the river's riparian zone is currently subject to urban encroachment. This encroachment becomes quite extensive in the Anderson/Redding area with homes placed directly within or adjacent to the riparian zone.

The Keswick to Red Bluff reach of the Sacramento River contains a large assemblage of resident and anadromous fish species, including commercially important species and species that are listed as threatened or endangered. Despite net losses of gravel since construction of Shasta Dam, substrates in much of this reach contain gravel needed for spawning by salmonids. This reach provides much of the remaining spawning and rearing habitat of several listed anadromous salmonids. As such, it is one of the most sensitive and important stream reaches in the State.

The upper Sacramento River system is unique in that it supports four separate runs of chinook salmon. Each is recognized by its season of upstream migration: fall-, late-fall-, winter-, and spring-run chinook salmon. As seen in **Figure III-4,** runs of fall- and spring-run salmon also occur on several tributaries of the Sacramento River. The adult population of the four runs of salmon and other important fish species (including steelhead trout), which also spawn upstream from Red Bluff, has significantly declined since the 1950s (see **Figure III-5**). Today, fall-run, late-fall-run and winter-run chinook salmon stocks and steelhead stocks in the Keswick to Red Bluff reach are augmented by production from the Coleman Fish Hatchery on Battle Creek.

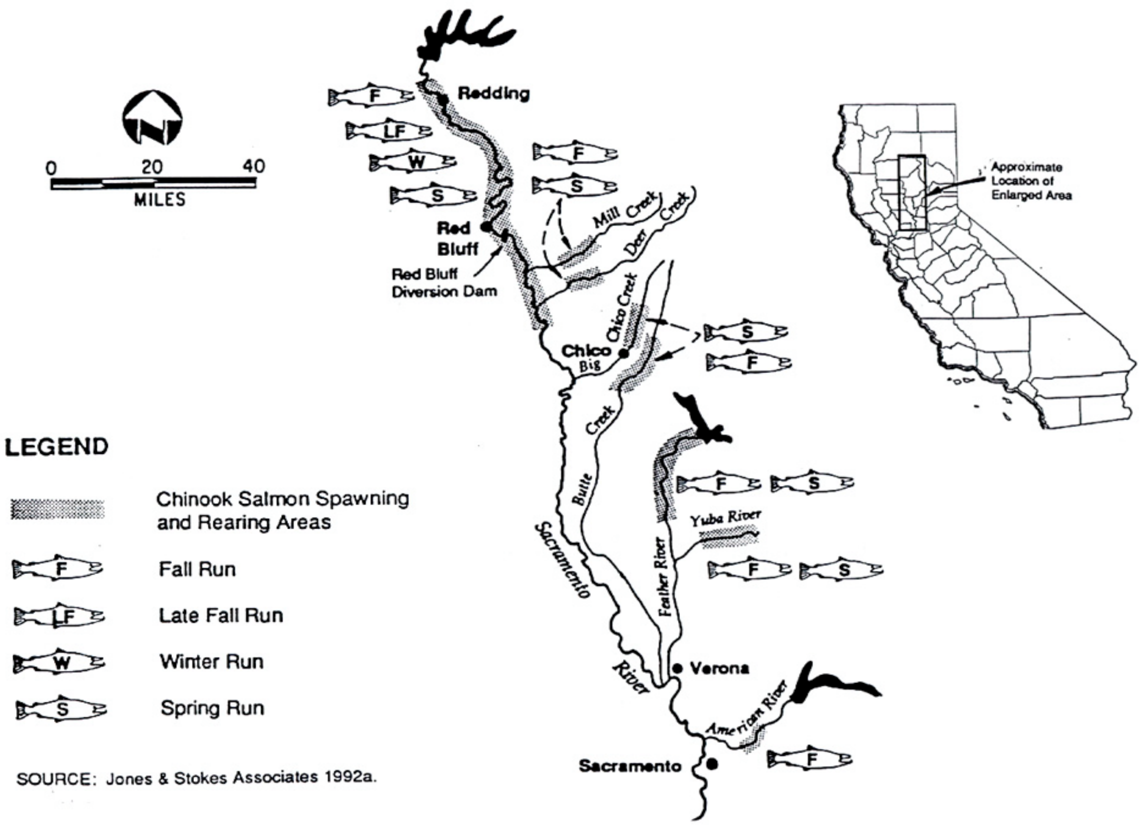


Figure III-4 - Major chinook salmon spawning and rearing areas in the Sacramento River watershed.

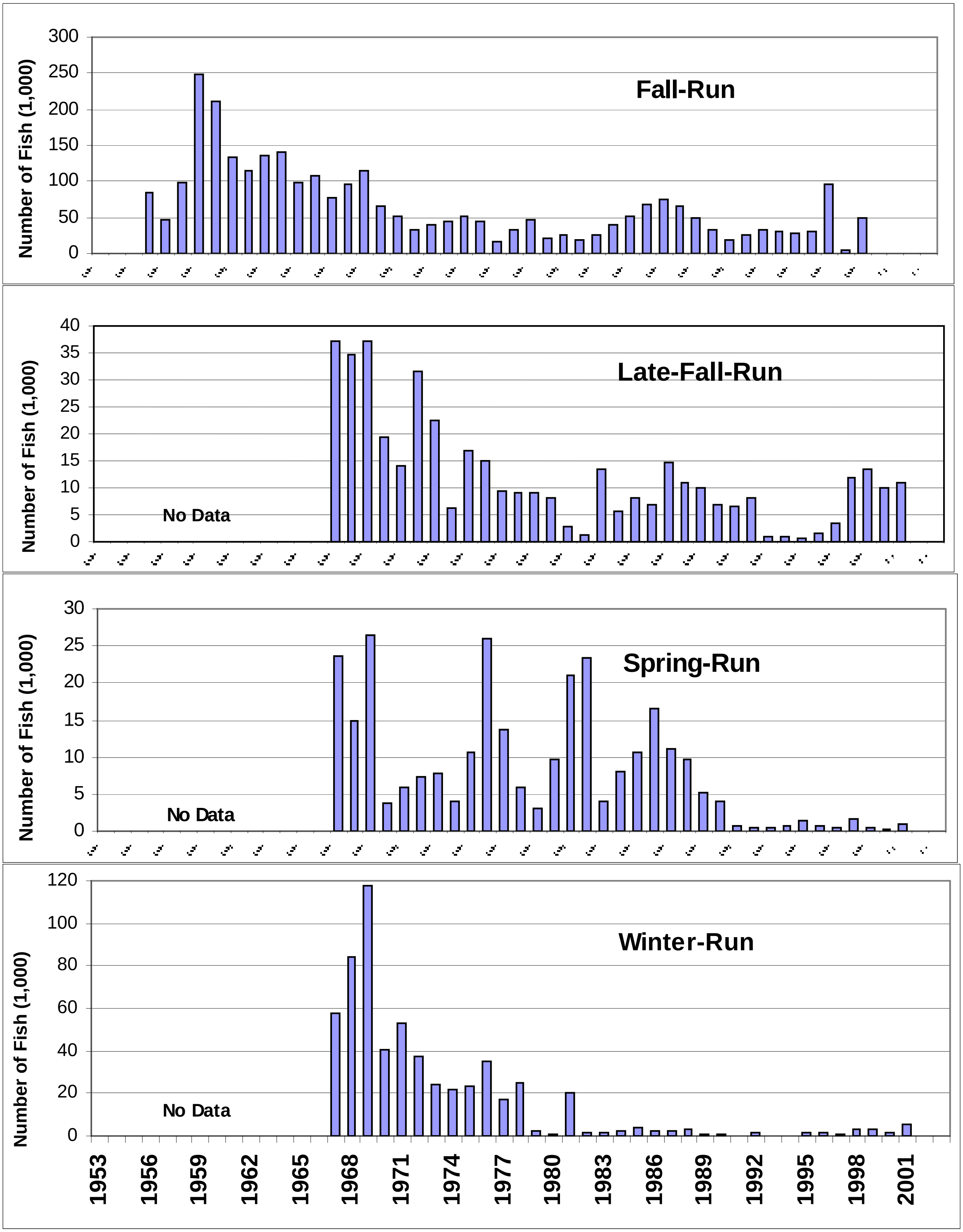


Figure III-5 - Estimated chinook salmon spawning escapement from the mainstem Sacramento River between 1953 and 2002.

- **Fall-run chinook salmon –** Fall-run chinook salmon were historically one of the more abundant salmon races in the Central Valley. Annual estimates of spawning escapement (total number of adult salmon aged 2 years and older that escape the fishery and return to spawn) in the mainstem Sacramento River have declined over the last 50 years. Annual run size declined from an average of about 180,000 adults during the 1950s and1960s to an average of about 77,000 during the 1970s through about 2000. Fall-run salmon are currently a candidate species for Federal listing.
- **Late-fall-run chinook salmon –** The number of late-fall-run chinook salmon passing the RBDD declined from an average of about 35,000 adults in the late 1960s to about 7,000 in recent years. Late-fall-run salmon are also a candidate species for Federal listing.
- **Winter-run chinook salmon –** With the possible exception of Battle Creek, the upper Sacramento River is the only spawning stream of winter-run chinook, which have been in a major decline since the 1960s. The return of only 550 adults in 1989 from an average annual population in the late 1960s of 80,000 adults prompted listing of winter-run chinook salmon as an endangered species by both the Federal Government and State of California.
- **Spring-run salmon –** The number of spring-run adult salmon passing the RBDD has fluctuated between highs of more than 25,000 fish to a low of about 770 in 1991. Because of the decline in spring-run salmon populations, spring-run salmon have been both Federally and State-listed as threatened.

Major factors that contribute to the decline in upper Sacramento River salmon populations include elevated water temperature; passage problems at the RBDD; modification and loss of spawning and rearing habitat due to construction of water resources projects; predation; pollution; and entertainment in water diversions on the Sacramento river and in the Delta. Drought conditions in the late 1980s and early 1990s also significantly contributed to population declines. Of these influencing factors, water temperature is one of the most important. Fortunately, cold water released from Shasta Dam significantly helps support spawning habitat in the reach below Keswick Dam. Without these cold water releases, winter-run salmon would possibly have become extinct, otherwise dispossessed of their historic spawning streams. However, temperatures still rise to levels harmful to salmon and steelhead trout.

Temperature impacts vary according to life cycle. Maximum survival of incubating salmon and steelhead eggs and yolk-sac larvae occurs at water temperatures between 41 and 56 degrees Fahrenheit, with no survival occurring at 62 degrees Fahrenheit or higher. After hatching, sac fry are completely dependent on the yoke sac for nourishment and may tolerate water temperatures up to 58 degrees. After juvenile salmon have emerged from the gravel and become independent of the yoke sac, the young salmon are able to tolerate water temperatures up to 67 degrees. Since winter-run and spring-run chinook salmon spawn during late spring and summer, they are particularly vulnerable to warmer water temperature conditions in the river.

For a period after Shasta Dam was constructed, the reservoir was kept relatively full and the cold water released from the hypolimnion provided cooler summer temperatures in the downstream reaches. The cold water releases created suitable conditions for winter-run and spring-run salmon to spawn in the mainstem Sacramento River below Shasta and Keswick Dams. Since winter-run salmon spawning habitat is almost entirely restricted to the Sacramento River between Keswick Dam and the RBDD, winter-run salmon survival is strongly tied to habitat conditions in this reach. In the late 1980s and early 1990s, because of a series of dry year conditions, storage space in Shasta Lake was decreased to satisfy water demands for agricultural, M&I, and other environmental uses (see **Plate 12**). This decrease in storage resulted in a depletion of the cold water pool, resulting in warmer water in the river and a higher mortality of salmon eggs.

The NMFS (now NOAA Fisheries) BO for winter-run chinook (1993) established water temperature objectives for the river upstream of Jellys Ferry (near RBDD) of 56 degrees Fahrenheit from April 15 through September 30, and 60 degrees for October. Recent changes in reservoir operations, including greater carryover storage, increased imports of cold water from the Trinity River system, and, most importantly, installation of a TCD on Shasta Dam, have substantially improved water temperature conditions in the reach.

In addition to anadromous salmonids, the Sacramento River contains resident rainbow trout and other native fishes. Resident rainbow trout are particularly abundant in the Keswick to Red Bluff reach. Their abundance is attributable to stable, cool summer flows resulting from Keswick Dam releases designed to enhance habitat conditions for winter-run salmon. The cool, nutrient-rich flows from the reservoir provide excellent rearing conditions for the trout. Other native species that reside in the Sacramento River upstream of Red Bluff include Sacramento pike minnow, Sacramento sucker, and hardhead minnow. White sturgeon and green sturgeon are native anadromous species that have been found at the RBDD. Green sturgeon has been proposed for Federal listing as endangered or threatened.

Vegetation

The Central Valley historically contained an estimated 1,400,000 acres of wetlands. Today, approximately 123,000 acres remain. Riparian and wetland habitats provide food and shelter to aquatic fauna, and attenuate high flows as well. The Sacramento River Valley contains a large diversity of both lowland and upland habitats and species. Along most of the Sacramento River and its tributaries, remnants of riparian communities are all that remain of once productive and extensive riparian areas. However, along the upper reaches of the Sacramento River, a higher percentage of the riparian vegetation is still intact. Vegetation in the river corridor varies from oak/gray pine and chaparral communities with very limited riparian vegetation above Redding to broad riparian ecosystems and agricultural lands from Redding to Red Bluff. Wetlands occupy many areas along Sacramento River waterways, but are not as extensive as the wetlands found in the Delta. However, grasslands and wooded upland communities are more abundant in this region. Agricultural lands also occupy a significant portion of the Sacramento River basin. Open-water areas occur mainly on the larger waterways, where waterways converge, and in reservoirs.

Shasta Lake and Vicinity

Shasta Lake is surrounded by mountainous terrain forested primarily by brushy, hardwood stands, chaparral, oak woodlands, mixed conifer forests and ponderosa pine-dominated conifer stands. Vegetation diversity tends to be high in the area, due largely to the favorable climate and varying geology. Elevation and sun exposure create variation in the forest stands around the lake. Vegetation in the Sacramento River watershed upstream from Shasta Lake can be separated into seven basic vegetation types: Douglas fir-mixed conifer forest, mixed conifer, Ponderosa pine, canyon oak woodland, black oak woodland, gray pine woodland, and chaparral. Elevation ranges for these vegetation types are between 1,065 feet (lake shore) and 5,100 feet (Schell Mountain). This elevation gradient travels through two transition zones: (1) valley (<1,500 feet) and lower montane (foothill) vegetation types and (2) lower montane (1,000 to 3,500 feet) and montane (>3,000 feet) vegetation types.

Lower elevation vegetation consists of a mix of chaparral and hardwoods; mid-elevation slopes are within a transitional zone that contains both the chaparral/hardwood mix and a mixed conifer component; and higher elevation sites are dominated by mixed conifer overstory with brush species in the understory primarily in open areas. An exception is in the riparian corridors where conifers can span from lower to upper elevations. Montane riparian vegetation is located in narrow belts along many of the tributaries.

Fire suppression activities during the 1900s have generally increased the amount of vegetation in the watersheds surrounding Shasta Lake, particularly understory brush and other forest floor vegetation. In general, increased vegetation in these areas contributes to lower rainfall runoff (more water retained in the soil) and slower erosion processes. Thick understory brush tends to burn hotter and wildfires become more devastating, with fewer trees and other large vegetation surviving. Wildfires in the area over the last century have resulted in significant loss of mature vegetation and slower forest recovery. Most of the recent logging in this area has occurred on private lands, with the exception of salvage logging on lands affected by forest fires.

Timber harvesting, water resource development, and environmental disasters also have affected riparian vegetation systems in this area. Riparian forests along the lower Sacramento, McCloud, and Pit rivers began diminishing as early as the mid-1800s when trees were harvested and floated downstream to support ore smelters. Water development and hydropower projects, including associated channelization, dam construction, and streamflow regulation, have also altered natural riparian systems and contributed to vegetation loss along major stream corridors. In particular, riparian vegetation succession has been significantly hampered on the lower Pit River due to water diversions and flow fluctuations. On the upper Sacramento River, vegetation along the river corridor was nearly completely destroyed in 1991 when a railroad car overturned and spilled a toxic herbicide into the river. The riparian vegetation has since recovered and associated aquatic and terrestrial wildlife are increasing in numbers. More recently, urbanization and recreation have contributed to the loss of riparian vegetation along the lower tributaries and shoreline of Shasta Lake.

Shoreline vegetation around Shasta Lake provides important cover for aquatic species and shade to maintain cooler water temperatures. Within the drawdown area of the lake, fluctuating water levels, wave action, and erosion have resulted in the loss of all but the heartiest vegetation. The lack of vegetation along the shoreline at certain reservoir levels negatively affects shallow aquatic habitat, which is the primary rearing habitat for juvenile fish in the lake.

Also of concern in the Shasta Lake area are non-native plant species, which were introduced to the region by early settlers. Some of the more invasive exotic species out-compete native vegetation and have required management actions within the subarea to prevent loss of habitat.

However, these management actions have been limited and confined primarily to areas adjacent to campgrounds and USFS facilities. Non-native species include yellow star thistle, Klamath weed (St. John's Wort), hedge parsley, several exotic grasses, and Himalayan blackberry.

Sacramento River

The type and diversity of vegetation from Shasta Dam to Red Bluff has changed significantly over the last 150 years. Primary factors influencing changes in vegetation and habitat are fire suppression and timber harvesting, land conversion, and invasive species. Fire suppression and timber harvesting methods through the mid-1900s created forests that were smaller, younger (less age diversity), and denser than those existing prior to settlement. This resulted in intense and devastating wildfires in the late 1900s, leading to modern fuel reduction and prescribed burn practices. Intensive grazing and conversion of habitat to agriculture also affected some areas, particularly lowland grasslands and riparian areas.

In the mid-1800s, settlers brought cattle and other grazers that imported nonnative grasses and other plants. Many exotic plants flourished and out-competed native vegetation. Today, numerous noxious and invasive plants are known to inhabit the area, including yellow star thistle, arundo (giant reed), pampas grass, cheat grass, hydrilla, Scotch broom, Himalayan blackberry, medusahead, tree of heaven, and edible fig. These nonnative species have significantly altered native habitats, particularly riparian and grassland communities, by changing vegetation density, water demand, and overall ecology.

Riparian Habitat – Vegetation in the river corridor varies from oak/gray pine and chaparral communities with very limited riparian vegetation above Redding to broad riparian ecosystems and agricultural lands from Redding to Red Bluff. Riparian vegetation along the Sacramento River corridor is in the valley foothill riparian association. This habitat has a canopy height of 100 feet with 20 to 80 percent closure. Plant species have specialized adaptations to life in an environment frequently disturbed by flooding and deposition. This vegetative complex provides necessary habitat for many species of native fish and wildlife. Primary native tree species within the riparian forests of the upper Sacramento River include Fremont cottonwood; white alder; California sycamore; black walnut; Oregon ash; red, black and yellow willow; and valley oak. Numerous native shrubs, vines, grasses and sedges are located within the understory of these trees and, in cases where tree cover is absent, provide the sole vegetative riparian cover.

While flooding of the lands adjacent to the river was an annual event lower in the Sacramento River system, the river above Red Bluff is more confined and entrenched. Consequently, riparian habitats are limited to areas immediately adjacent to the Sacramento River and along tributary streams. Historically, these small areas probably did not contain the breadth of habitat necessary to support the complex riparian ecosystem found in the gallery riparian forests south of Red Bluff. Riparian forest communities in the subarea include cottonwood, alder, ash, sycamore, walnut, willow, and valley oak.

Also, since the river immediately below Keswick is deeply incised in bedrock, riparian vegetation is very limited and no functioning riparian ecosystems occur. Near Redding, the river comes into the valley and the floodplain, which historically had wide expanses of riparian forests, broadens. However, the river's riparian zone from Balls Ferry to Keswick is subject to considerable urban encroachment.

A breakdown of riparian habitats within the 100-year floodplain between Keswick Dam and Red Bluff is shown in **Table III-7**. Non-native species, urban development, and water resources development have reduced and fragmented riparian communities, particularly along the Sacramento River, Battle Creek, and Cow Creek. Freshwater marsh, vernal pools, seeps, montane wet meadows, and other wetland communities are also highly fragmented and scattered throughout this area.

TABLE III-7
RIPARIAN AND RELATED HABITATS WITHIN THE 100-YEAR FLOODPLAIN ALONG THE SACRAMENTO RIVER BETWEEN KESWICK AND RED BLUFF

Vegetation Type	Acres	Percent of Land Surface Area
Riparian forests	2,801	15%
Riparian scrub	1,439	8%
Valley oak woodland	315	2%
Marsh	58	<1%
Blackberry scrub	61	<1%
Total Riparian Vegetation	**4,674**	**26%**

Wetland Habitat – While often combined with riparian ecosystems, wetlands within the study area are defined as shallow to moderately deep open water areas having a vegetative component of emergent and aquatic species (specifically cattails, rushes, and sedges). Wetlands are normally the result of annual flooding that breaches natural levees along the river, resulting in shallow pools of semipermanent water. Fairly significant wetland areas exist on tributaries to Shasta Lake and to a limited extent along the Sacramento River downstream to Red Bluff.

Upland Habitat – Upland habitats downstream from Shasta Dam include categories based on elevation and soil conditions, such as valley oak woodland adjacent to the river from Redding to Red Bluff, and blue oak/digger pine (foothill or grey pine) and montane hardwood/conifer associations from Shasta Dam downstream to Redding.

The valley oak woodland association varies from savannah-like to more dense forests with partial canopy-closure. Valley oak woodland is usually associated with conditions where trees can put roots into a permanent water supply, such as along drainages. These woodlands provide abundant food and cover for many species of wildlife.

The blue oak/foothill pine association is diverse structurally, both horizontally and vertically. The understory shrub layer is sparse and may be limited to annual grassland.

The montane hardwood/conifer association consists of Ponderosa pine, sugar pine, Douglas fir, white fir, incense cedar, black oak, Oregon white oak, and canyon live oak, with relatively little understory. Because of its variety of vegetation, and close proximity to other associations, this habitat type provides for a diverse fauna. These mixed conifer forests occur in the higher foothill and mountain elevations in the area, typically above 2,000 feet. Fire suppression has been the major factor affecting the health of mixed conifer habitat within the region, resulting in increasingly dense understory vegetation, including manzanita, poison oak, California redbud, and various non-native species.

Unlike the highly fragmented riparian communities, blue oak/digger pine and montane hardwood/conifer associations are found along nearly continuous elevation bands or belts, both to the east and west of the Sacramento River.

A limited amount of white fir and red fir true conifer forest exists in the mountains to the east of the Sacramento River, primarily above 5,000 feet.

Wildlife

The composition, abundance, and distribution of wildlife resources in the Sacramento Valley are directly related to available habitat. Wildlife resources in the primary study area include habitat conditions suitable for over 200 species of birds and 55 species of mammals, reptiles, and amphibians. Typical species include hummingbird, swallow, owl, ducks, ravens, geese, gray squirrel, black bear, deer, and elk. Lower elevation areas in the McCloud River, Sacramento River, Pit River, and Squaw Creek drainages are also winter ranges for deer. Elk winter range is located on the McCloud River and Pit River peninsulas. Overall, however, fewer wildlife species now inhabit the study area than before agricultural and residential development permanently removed much of the native and natural habitat. Many of the wildlife species are unable to adapt to other habitat types or altered habitat conditions and are, therefore, most susceptible to habitat loss and degradation. Species that depended on riparian woodland, oak woodland, marsh, and grassland habitats have declined.

A variety of wildlife is present in the areas surrounding Shasta Lake, including black-tailed deer, elk, black bear, lion, bobcat, gray squirrel, rabbit, and turkey. Avian species include quail, falcon, eagle, turkey, dove, pigeon, hawk, woodpecker, ash-throated flycatcher, Hutton’s and warbling vireos, and house sparrow. The area provides excellent habitat for deer and elk, and suitable habitat for numerous bat species, although there have been few confirmed bat sightings. Several other wildlife species inhabited this area prior to European settlement but were extirpated by over-hunting or because they were seen as threats, including grizzly bear, wolf, and various species of elk.

Shasta Lake is home to the largest concentration of nesting bald eagles in California. There are three bald eagle territories on the Sacramento River arm alone: Little Squaw, Bass Point, and Frost Gulch. Bald eagles also nest near Lake Britton and along the lower Pit River. The High Complex Fire of 1999, which killed numerous large pines, may have affected potential nesting and roosting areas around Shasta Lake.

Timber harvesting, fire suppression, recreation, and wildfires have affected the population and distribution of wildlife in this area. Fire suppression, which has generally increased understory vegetation, has had mixed effects on wildlife. Bear, deer, and birds that prefer near-ground vegetation for food and cover have generally benefited, while birds requiring aerial foraging, such as the golden eagle, peregrine falcon, and great-horned owl, have declined. Species that have adapted or thrived in the altered human environment include coyote, raccoons, and various late-successional species. Potential bat habitat, found primarily in the limestone formations to the north and east of Shasta Lake, has suffered from increased use by recreational rock climbers and spelunkers. Wildlife may also be impacted by a lack of contiguous travel corridors in certain portions of the area that prevent species from moving between remaining suitable habitat.

The diverse habitats present in the Shasta Dam to Red Bluff portion of the primary study area support a variety of wildlife. Existing native habitat, especially riparian corridors along the Sacramento River and associated sloughs and creeks, provides habitat for many native species. While riparian habitat is limited in this area, it supports the greatest abundance of wildlife, including a variety of avian species such as waterfowl and raptors; rodents such as skunk and opossum; frogs, toads, and other amphibians; bats; coyote and fox; garter snake and other reptiles. Riparian habitat provides shade, cover, and food supply to the immediate shoreline environment of large rivers, benefiting fish and wildlife species such as salmonids, native fish, river otter, beaver, heron, egret, and kingfisher.

Lower elevation grasslands and oak woodlands host a variety of seasonal game species and other wildlife, such as deer, jackrabbit, coyote, hawk and other raptors, gopher snake, pheasant, fox, raccoon, and quail. The grasslands and foothills also support vernal pools and other seasonal wetlands that provide unique habitat for waterfowl and various small aquatic organisms.

More arid chaparral habitat and scrub habitat support a variety of reptiles, weasel, wild pig, skunk, coyote, and larger mammals such as deer, bobcat, and mountain lion. Bird species that forage and nest in brush habitat within the area include wild turkey, pigeon, California thrasher, California towhee, and California quail.

Higher elevation forest habitats support woodpecker, marten, fishers, owls, eagle, forest-floor amphibians such as newt, a variety of reptiles, black bear, gray fox, mountain lion, deer, and feral pig. Due to a sharp decline in deer populations, deer herds are managed within portions of the area, including the Yolla Bolly Deer Herd in the Cottonwood Creek watershed and the Cow Creek Deer Herd.

Exotic wildlife species include the brown-headed cowbird, feral pig, wild turkey, pheasant, chukar, elk, and bullfrog. Some of these exotic species have been detrimental to native vegetation and wildlife, such as the cowbird (which parasitizes the nests of other birds) and feral pigs (which uproot native vegetation and the nests of ground-nesting birds).

Because animals are highly dependent on their choice habitats, changes in the quality and quantity of various habitat types have impacted area wildlife. The wildlife most affected in this area have been those associated with riparian and grassland habitats, which have been highly impacted by land use, water resources development, and land management practices. Wildlife populations are also influenced by the age and density of the vegetation within the various habitat types. The general trend toward more dense underbrush in foothill and mountain habitats, due to fire suppression, has favored species that rely on dense vegetation for cover or foraging while negatively impacting raptors and other wildlife that require open areas for foraging. Land conversion and the introduction of non-native species have had similar positive and negative effects on wildlife in riparian and grassland areas. Although mountainous terrain in this area tends to be less developed, timber harvesting and fire suppression have changed the suitability of some areas for various types of wildlife.

Special-Status Species

The Sacramento River basin is home to numerous special-status plants and animal species as described by Federal and State agencies: 65 special-status plant species, 9 special-status fish species, and 39 special-status wildlife species. Most of the plant species live in grasslands, including vernal pools. The next greatest number of special-status species inhabits chaparral and montane hardwood areas. Most of the special-status fish and wildlife species inhabit grasslands, freshwater emergent wetlands, lakes, and rivers on the valley floor.

Plants

Plants considered by the State and/or USFS to require special attention are designated as "sensitive." Plants potentially within the study area under this designation are shown in **Table III-8**. No known populations of listed plants occur in the study area.

TABLE III-8
POTENTIAL HABITAT FOR SPECIAL-STATUS PLANTS
IN THE SHASTA LAKE WATERSHED

Species	Status	Habitat	Nearest Population to Watershed
Arnica venosa Veiny arnica	Endemic	Hot dry slopes under pine, black oak, and Douglas fir; usually on north-facing aspects or ridgetops. Elevation 1,500-5,000.	Two populations occur in the primary study area.
Cypripedium faciculatum Clustered lady's slipper	Sensitive	Mixed conifer or oak forests on a variety of soil types, often but not always associated with streams; widespread but sporadic. Elevation 1,300-6,000.	No known populations on the Shasta side of the forest. Several populations occur on the Trinity side of the forest.
Cypripedium montanum Mountain lady's slipper	Sensitive	Mixed conifer or oak forests on a variety of soil types, often but not always associated with streams; widespread but sporadic. Elevation 1,300-6,000.	One known population occurs along the Soda Creek Road approximately 18 miles northeast of the watershed.
Lewisia cantelovii Cantelow's lewisia	Sensitive	Moist rock outcrops in broad-leaf and conifer forests. Elevation 500 to 3,000.	Two known populations occur near Lamoine, approximately 2 miles north of the watershed.
Neviusia cliftonii Shasta snow-wreath	Sensitive	North facing slopes on limestone-derived soils, within riparian zones. Elevation 2,400 to 3,000.	One known population, three miles east in Waters Gulch; potential habitat in limestone outcrops on Big Backbone Creek and Little Backbone Creek.

Source: Shasta Lake West Watershed Analysis. USFS, 2001.

Fish and Wildlife

Within the primary study area, there is potential for occupancy by 12 species listed as threatened or endangered under the Federal ESA and/or the California Endangered Species Act (CESA). These species (see **Table III-9**) are provided protection by one or both of these acts and any actions resulting in take must be permitted by USFWS and CDFG. In addition, the study area has the potential to host species of special concern, also shown in **Table III-9**. Species of special concern, while not offered protection under the endangered species acts, require analysis and mitigation under the California Environmental Quality Act (CEQA).

TABLE III-9
ENDANGERED, THREATENED, AND SPECIAL-STATUS FISH AND WILDLIFE POTENTIALLY INHABITING THE SHASTA LAKE WATERSHED

Species	Status	Habitat
Federal and State Threatened and Endangered Species		
Bald eagle	FT, SE	Riparian zones along larger rivers and open water areas w/large trees for nesting and roosting
Bank swallow	ST	Steep river banks and banks near water sources
Bull trout	SE, FT	McCloud River
California red-legged frog	FT	Still or slow-moving water w/shrubby riparian vegetation. Extinct in study area.
Chinook salmon (spring-run)	FT, ST	Sacramento River and tributaries
Chinook salmon (winter-run)	FE, SE	Sacramento River and tributaries
Peregrine falcon	SE	Riparian zones for wintering habitat
Shasta salamander	ST	McCloud River, Pit River, and Squaw Creek in moist limestone fissures and caves
Steelhead	FT	Sacramento River and tributaries
Swainson's hawk	ST	Riparian areas w/ large trees for nesting; adjacent open lands for foraging
Valley elderberry longhorn beetle	FE	Riparian; requires mature elderberry bushes
Yellow-billed cuckoo	SE	Riparian forests greater than 50 acres
Species of Special Concern		
Black tern	SC	Marsh lands w/permanent open water
Burrowing owl	SC	Grasslands
California gull	SC	Wintering populations only; riverine and wetlands
California horned lark	SC	Grasslands
California tiger salamander	SC	Wetland and vernal pools and adjacent uplands
Chinook salmon (fall/late-fall-run)	SC	Sacramento River and tributaries
Cooper's hawk	SC	Riparian zones
Ferruginous hawk	SC	Wintering populations only; grasslands
Foothill yellow-legged frog	SC	Shallow river and streams with gravel bottoms
Hardhead minnow	SC	Shasta Reservoir and tributaries
Tri-colored blackbird	SC	Marsh
Loggerhead shrike	SC	Oak woodland
Long-billed curlew	SC	Grasslands and irrigated pastures
Long-eared owl	SC	Riparian habitat w/dense canopies
Merlin	SC	Riparian zones for wintering habitat
Purple marten	SC	Riparian forests
Sharp-shinned hawk	SC	Riparian zones
Short-eared owl	SC	Open areas, grasslands, irrigated pasture
Osprey	SC	Riparian zones along larger rivers and open water areas w/large trees for nesting and roosting
Vaux's swift	SC	Coniferous (Douglas fir) habitats; snags
Western least bittern	SC	Marshy areas with emergent vegetative cover
Western pond turtle	SC	Moderate to deep slow-moving rivers, ponds, and streams having deep pools.
Western spadefoot toad	SC	Vernal pools and ponds
White-faced ibis	SC	Irrigated pastures, shallow marsh
Yellow-breasted chat	SC	Riparian scrub
Yellow warbler	SC	Riparian scrub/forests

Key:
FE – Federally listed as endangered FT – Federally listed as threatened
SC – Regarded by USFWS and/or CDFG as a species of special concern
SE – State-listed as endangered ST – State-listed as threatened

Survey and Manage Species

Portions of the study area, primarily around Shasta Lake, lie within federal lands managed by BLM and the USFS STNF. The Northwest Forest Plan identifies species that are rare or sensitive and require special management and/or mitigation actions. USFS Sensitive and Northwest Forest Plan Survey and Manage species potentially located within the study area are shown in **Tables III-10** and **III-11**.

TABLE III-10
USFS SENSITIVE AND SURVEY AND MANAGE FLORAL SPECIES POTENTIALLY OCCURRING IN THE SHASTA LAKE WATERSHED

Species	Status	Habitat
Ageratina shastensis Shasta ageratina	USFS Endemic	Limestone outcrops
Bondarzewia montana Bondarzewia fungus	S&M	Mixed conifer and conifer/woodland habitats
Botrychium inc. *B. crenulatum* Moonwort, grape-fern	USFS Sensitive	Mixed conifer and conifer/hardwood habitats
Botrychium minganese Moonwort	S&M	Mixed conifer and conifer/woodland habitats
Botrychium montanum Moonwort	S&M	Mixed conifer and conifer/woodland habitats
Buxbaumia viridis Bryophyte	S&M	Mixed conifer and conifer/woodland habitats
Cypripedium fasciculatum Clustered lady’s slipper	S&M	Lower montane coniferous forest
Cypripedium montanum Mountain lady’s slipper	S&M	Cismontane woodland and lower montane coniferous forest habitats
Lewisia cantelovii Cantelow’s lewisia	USFS Sensitive	Chaparral, cismontane woodland, and lower montane coniferous forest habitats
Neviusia cliftonii Shasta snow-wreath	USFS Sensitive	Cismontane woodland, lower montane coniferous forest, and riparian woodland habitats
Otidea leporina Otidea fungus	S&M	Mixed conifer and conifer/woodland habitats
Polyozellus mulitplex Blue chantrelle	S&M	Mixed conifer and conifer/woodland habitats
Ptilidium californicum Pacific fuzzwort	S&M	Mixed conifer and conifer/woodland habitats
Schistostega pennata Bug on a stick	S&M	Mixed conifer and conifer/woodland habitats
Smilax jamesii English Peak greenbriar	USFS Sensitive	Lower montane coniferous forest, marshes, and swamp habitats
(Aleuria) Snowerbyella rhenana Orange peel fungus	S&M	Mixed conifer and conifer/woodland habitats

Key:
S&M – Survey and Manage Species considered rare or threatened per the Northwest Forest Plan, 2002.
USFS Endemic – Species considered sensitive by the USFS that are endemic to habitat found in specific regions or National Forests.
USFS Sensitive – Species considered sensitive by United States Forest Service (USFS).

TABLE III-11
USFS SENSITIVE AND SURVEY AND MANAGE FAUNAL SPECIES POTENTIALLY OCCURRING IN THE SHASTA LAKE WATERSHED

Species	Status	Habitat
Hydromantes shastae Shasta salamander	S&M	Mixed conifer, woodland, and chaparral habitats, especially limestone outcroppings
Rana boylii Foothill yellow-legged frog	USFS Sensitive	Stream habitats
Clemmys marmorata Northwestern pond turtle	USFS Sensitive	Stream or wetland habitats
Naccipiter gentilis Northern goshawk	USFS Sensitive	Mixed conifer forests
Falco peregrinus Peregrine falcon	USFS Sensitive	Mixed conifer and conifer/woodland habitats
Plecotus townsendii Townsend's big-eared bat	USFS Sensitive	Mixed conifer and conifer/woodland habitats
Antrozous pallidus Pallid bat	USFS Sensitive	Mixed conifer and conifer/woodland habitats
Monadeia troglodytes troglodytes Shasta sideband	S&M	Terrestrial mollusk inhabiting mixed conifer and woodland habitats, especially with limestone outcroppings
Monadenia troglodytes wintu Wintu sideband	S&M	Terrestrial mollusk inhabiting mixed conifer and woodland habitats, especially with limestone outcroppings
Trilobopsis roperi Shasta chaparral	S&M	Terrestrial mollusk inhabiting mixed conifer and conifer/woodland habitats
Vespericola shasta Shasta herperian	S&M	Terrestrial mollusk inhabiting mixed conifer and conifer woodland habitats
Fluminicola seminalis Nugget pebblesnail	S&M	Aquatic mollusk inhabiting mixed conifer and conifer/woodland habitats
Fluminicola sp. 14 Potem pebblesnail	S&M	Aquatic mollusk inhabiting mixed conifer and conifer/woodland habitats
Fluminicola sp. 15 Flat-top pebblesnail	S&M	Aquatic mollusk inhabiting mixed conifer and conifer/woodland habitats
Fluminicola sp. 16 Shasta pebblesnail	S&M	Aquatic mollusk inhabiting mixed conifer and conifer/woodland habitats
Fluminicola sp. 17 Disjunct pebblesnail	S&M	Aquatic mollusk inhabiting mixed conifer and conifer/woodland habitats
Fluminicola sp. 18 Globular pebblesnail	S&M	Aquatic mollusk inhabiting mixed conifer and conifer/woodland habitats
Juga (Orebasis) sp. 3 Cinnamon juga	S&M	Aquatic mollusk inhabiting mixed conifer and conifer/woodland habitats
Lyogyrus sp. 3 Canary duskysnail	S&M	Aquatic mollusk inhabiting mixed conifer and conifer/woodland habitats
Vorticifex sp. 1 Knobby rams-horn	S&M	Aquatic mollusk inhabiting mixed conifer and conifer/woodland habitats

Key:
S&M – Survey and Manage Species considered rare or threatened per the Northwest Forest Plan, 2002.
USFS Sensitive – Species considered sensitive by United States Forest Service.

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Wild and Scenic Rivers

In the Shasta Dam area, the free-flowing stretches of the McCloud River are protected under the California Wild and Scenic River Act of 2002 (Public Resources Code Section 5093.50). Under the act, the State legislature found that "maintaining the McCloud River in its free-flowing condition to protect its fishery is the highest and most beneficial use of water." The act restricts construction of dams, reservoirs, diversions, or other water impoundment facilities on the McCloud River from the location of the present confluence of the McCloud River with Shasta Reservoir (McCloud Bridge). With the exception of participation by DWR in studies involving the feasibility of enlarging Shasta Dam, the act prohibits any State department or agency from assisting or cooperating with any agency of the Federal, State, or local governments in planning or constructing any facility that could have an adverse effect on the free-flowing condition of the McCloud River or on its wild trout fishery.

Social and Economic Resources

Existing social and economic resources described in this section include population, land use, employment and business/industrial activities, local government and finance, public health and safety, traffic and transportation, recreation and public access, utilities and public services, water supply, power and energy, hazardous materials and waste, fire hazards, natural resources, and aesthetics.

Population

The number of persons living in California as of 2000 totaled an estimated 35 million. Approximately 2.7 million and 1.9 million of this population resided in the Sacramento and San Joaquin River basins portion of the Central Valley, respectively. The population in the primary study area in Shasta and Tehama counties totaled over 230,000. About three-fourths of the population in the Sacramento River Basin resides in or near the City of Sacramento. In California, population growth during the 1990-2000 decade totaled approximately 4.6 million persons, or a growth rate of about 15 percent. The growth rate in the Sacramento and San Joaquin River basins was significantly greater, at over 20 and 30 percent for the same period, respectively.

Population growth in the Central Valley and throughout the State has created demands for land and water resources for residential, commercial, and infrastructure uses. As population has increased, urbanization has caused substantial amounts of land to be converted from agriculture, wetland, open space, and other land use categories to roads, parks, housing, retail stores, office space, and other urban uses. Population increases also have included increased demand for a more dependable water supply.

Land Use

Land uses in the Sacramento River Valley are principally agricultural and open space, with urban development focused in the Sacramento metropolitan area. Urban development has occurred along major highway corridors, primarily in Sacramento, Placer, El Dorado, Yolo, Solano, and Sutter counties, and has caused some agricultural land to be taken out of production. Soil conditions in the basin allow a wide variation in crop mix.

The primary private land use in the region is agriculture. As of 1997, California's 74,126 farms included a total of 27.7 million acres. Of that, the Sacramento River Valley area had over 11,000 farms with about 4.3 million acres. Shasta County's 850 farms encompassed a total of almost 317,000 acres. The region has extensive tracts of Federal and State land, including portions of the Shasta-Trinity, Lassen, Plumas, and Mendocino national forests plus several Federally or State-owned wildlife management areas.

Employment and Business/Industrial Activities

It is estimated that in August 2002, California's civilian labor force totaled 17.5 million. During 2001, approximately 1.2 million persons, or half of the people in the Sacramento River Valley area, were in the civilian labor force. The area's rate of unemployment ranged from 4.1 percent in Solano County to 17.6 percent in Colusa County. For 2001, Shasta County had a labor force that averaged 76,487, of whom 71,332 were employed and 5,155 unemployed (this represents an unemployment rate of 6.7 percent).

The State's economy is based on the manufacture of computers and electronic products, transportation equipment (particularly aerospace products), fabricated metal products and machinery, food processing, business services, and farming. The economy of the central and northern counties in the Central Valley is based on lumbering, the manufacture of wood products, farming, and food processing. In 2000, manufacturing establishments employed 74,046 workers in the Central Valley. Shasta County manufacturers accounted for 5,039 of these jobs or 6.8 percent for the area. The manufacturing sector in the Central Valley had sales totaling almost $17.0 billion, and Shasta County's manufacturing establishments earned $635 million.

Shasta County's economy has expanded as the result of the provision of new health service facilities, shopping centers, and recreational services for nonresidents of that county. Tourism, recreation, and related hospitality industries are a major source of economic development in the primary study area. In 1998, travel-related spending alone exceeded $360 million in Shasta County, generating over 4,600 jobs. Shasta Lake and the Sacramento River play a central role in the tourism industry and the appeal of the region to prospective businesses and investors.

Local Government and Finance

Local government services in California are provided by counties, school districts, fire districts, water districts, and other special districts. Based on 1997 census data, it is estimated that local governmental units operating within the 10-county Sacramento River Valley area had combined revenues totaling almost $8.8 billion or about $3,950 per regional resident. Shasta County's governmental units had combined revenue of about $644 million or $3,983 per resident. Forty-one percent of the combined revenue of all the local governmental units operating within the Sacramento River valley area was derived from the transfer of State governmental revenue and about nineteen percent from local taxes.

Public Health and Safety

Data from the 1997 census indicate that local governmental units operating within the region employed about 4,200 full-time workers and spent about $310 million, or $139 per regional resident, to provide health and hospital services. Local governmental units in Shasta County spent about $36 million, or $223 per county resident, on providing public health services. Shasta and Tehama counties are the only jurisdictions in the Sacramento River Valley area in which hospital care is provided by local government.

State police, county sheriffs, fire districts, and county-run detention facilities provide public safety in California's rural areas and smaller incorporated places. Larger cities in the State almost always provide police and fire services within their jurisdictions. In 1997, local governments within the Sacramento Valley employed about 7,500 workers to provide police and fire protection. This number included about 5,000 workers for police protection and about 2,400 for fire protection. Shasta County's local governments employed a total of 467 workers to provide public safety, including 364 for police protection and 103 for fire protection. Annual expenditures for public safety in the Sacramento River Valley area totaled $732 million or $329 per regional resident. The provision of public safety in Shasta County cost $48 million or $297 per county resident.

Traffic and Transportation

Major transportation routes in the study area include I-5, which traverses the valley from north to south; State Route 299, an east-west route, which traverses Trinity, Shasta, Lassen, and Modoc counties in the northern watershed areas; and State Route 99 and State Route 70, portions of which are expressway, and run north-south from Sacramento northward toward Chico. The upper watershed areas west and east of the Sacramento Valley contain a network of State highways. Major routes on the west side of the valley include State Route 29, which runs north-south through Napa and Lake counties, and several east-west freeways, including State Route 20 in Lake County, State Route 162 in Glenn County, and State Route 36 in Tehama and Trinity counties. Excluding Chico, traffic within the central and northern portions of the Central Valley usually is moderate to light. During weekends and holidays from May 1 through Labor Day, however, heavy traffic in the Redding-Shasta Lake area is not unusual.

Recreation and Public Access

Major recreation areas in the Sacramento River Basin include lakes and reservoirs, rivers and streams, Federal wildlife refuges, and State wildlife management areas. Private lands also support considerable waterfowl hunting activity in the region. Shasta Lake, Whiskeytown Lake, Lake Oroville, Folsom Lake, New Bullards Bar Reservoir, and Englebright Lake provide extensive reservoir recreation opportunities, including flat-water recreation.

Information from the 1997 census indicates the importance of outdoor recreation in Shasta County. The county's accommodation and food services establishments had sales totaling $162 million, or almost $1,000 per county resident. This per capita amount is the highest of all the counties in the Sacramento River basin. Outdoor recreation and tourism in Shasta County is the result of Shasta Lake. USFS personnel in Redding report that the lake has attracted the development of 11 marinas with 1,075 houseboats, including 625 that are privately owned and 450 that are owned by a marina and rented on a weekly or weekend basis, and 18 developed public campgrounds with a total of 246 sites. In addition, several of the lake's marinas have developed rental campsites and numerous cabins on land leased from USFS. Access to most of the campgrounds, day-use areas, and marina/resorts around Lake Shasta is provided by I-5 and secondary roads maintained by USFS or Shasta County.

Utilities and Public Services

Various departments within the cities and counties of the Sacramento River Valley provide fire protection, police protection, and emergency services to members of their communities. A vast network of utility generation/transmission systems and service providers exists across all regions of the study area, supplying urban and rural areas with power, water, and emergency services. Other significant infrastructure consists of hydroelectric and natural gas-fired generating facilities, transmission lines, substations, distribution lines, fiber optic and cable lines, and communication towers. Pipelines, storage areas, and compressor stations also are located in the Sacramento Valley.

Water Supply

On the basis of information contained in the 1998 DWR California Water Plan (Bulletin 160-98), it is estimated that water demands (applied water) in the State in 2000 for urban, agricultural, and environmental purposes under average and drought year conditions amounted to about 79.7 and 65 MAF, respectively (see **Table III-12**). To address this demand, available statewide supplies from surface water, groundwater, and recycled and desalted sources also under average and drought year conditions amounted to about 78 and 60 MAF, respectively. During average years, about 83 percent of the available supplies come from surface water sources and 16 percent from groundwater. In dry years, water from surface water sources declines to about 73 percent of the available supplies and nearly all of the remainder (about 26 percent) comes from groundwater.

Similar conditions existed in the Central Valley. As can be seen in **Table III-12**, estimated 2000 water use (demands) during average and drought years in the Sacramento River and San Joaquin River basins were about 26 and 24 MAF, respectively. The total estimated water supply for average and drought year conditions was about 25 and 22 MAF, respectively. The estimated net water demands (or shortages) for drought year conditions amounted to about 1.7 MAF.

The largest water supply provider in the Central Valley is the CVP. The total annual contract water amount in the CVP is about 8.3 MAF. However, the project can only deliver portions of this amount depending on various conditions. As presented in Bulletin 160-98, the CVP has a 7 MAF delivery capability under average year conditions. Of this 7 MAF, 3 MAF are in the Northern (Sacramento) CVP System, 2.7 MAF in the Southern (San Joaquin) CVP System, and 1.3 MAF in the Eastside and Friant divisions. On the basis of more recent system modeling runs, however, it is estimated that system delivery capability under average year conditions, based on 2000 demands, is about 10 percent less, at an estimated 6.3 MAF. In addition, **Figure III-6** shows the expected frequency of the Northern and Southern CVP systems meeting estimated annual deliveries under current conditions. As can be seen, it is estimated that in about 80 percent of the years, the system can deliver at least 4.5 MAF and in 20 percent of the years at least 5.8 MAF. The median annual delivery (50 percent exceedance) is about 5.5 MAF. Accordingly, it is highly likely that the potential shortages in **Table III-12** are significantly underestimated.

TABLE III-12
ESTIMATED WATER DEMANDS, SUPPLIES, AND SHORTAGES FOR 1995

	Hydrologic Basin						State of California	
	Sacramento River		San Joaquin River		Two-Basin Total			
Item	Average Year	Drought Year	Average Year	Drought Year	Average Year	Drought Year	Average Year	Drought Year
Population	2.7		1.9		4.5		34.9	
Urban Use Rate (GPCPD)	282	306	309	314	293	309	241	247
Acres in Production (mil)	2.1		2		4.1		9.5	
Agricultural Use (AFPA)	3.8	4.2	3.5	3.6	3.6	3.9	3.5	3.6
Applied Water (MAF)								
Urban	.8	.9	.7	.7	1.5	1.6	9.4	9.7
Agricultural	8.0	9.0	6.9	7.1	15.0	16.1	33.3	34.1
Environmental	5.8	4.2	3.4	1.9	9.2	6.1	36.9	21.2
Total	***14.7***	***14.1***	***11.0***	***9.7***	***25.7***	***23.8***	***79.7***	***65.0***
Water Supply (MAF)								
Surface Water	11.9	10.0	8.5	6.0	20.5	16.1	65.1	43.5
Groundwater	2.7	3.2	2.2	2.9	4.9	6.1	12.5	15.8
Recycled/Desalted	0	0	0	0	0	0	.3	.3
Total	***14.6***	***13.3***	***10.8***	***8.9***	***25.4***	***22.2***	***77.9***	***59.7***
Shortage (MAF)	**.1**	**.9**	**.2**	**.8**	**.3**	**1.7**	**1.8**	**5.4**

Key:
AFPA – acre-feet per acre
GPCPD – gallons per capita per day
MAF – million acre-feet
mil – million

Source: California Water Plan, Bulletin 160-98, Appendix 6A, Regional Water Budgets with Existing Facilities and Programs, November 1998.

When deficiencies in the ability of the system to deliver full entitlements occur, as indicated in **Table III-12** and **Figure III-6**, deliveries are reduced by varying percentages based on demand type (e.g., refuges, settlement contracts, and CVP contracts). Priority deliveries include water for wildlife refuges north and south of the Delta and water required by CVP Exchange and Settlement Contractors. Discretionary deliveries, which can be shorted significantly depending on the type of water year, include agricultural and M&I CVP contractors both north and south of the Delta.

Power/Energy

Major energy generators in the study area include the SWP, CVP, and private suppliers. The primary purpose of SWP power generation facilities is to meet energy requirements for SWP pumping plants. To the extent possible, SWP pumping is scheduled during off-peak periods, and energy generation is scheduled during on-peak periods. Although the SWP uses more energy than it generates from its hydroelectric facilities, DWR has exchange agreements with other utility companies and has developed other power resources. When available, surplus power is sold by DWR to minimize the net cost of pumping energy.

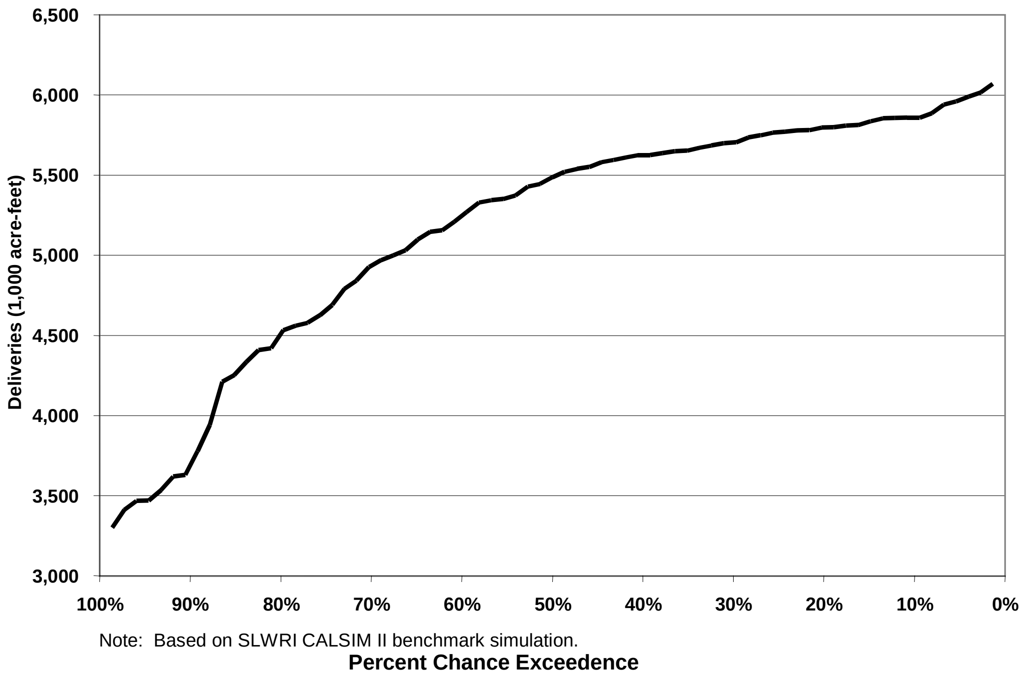

Figure III-6 – Estimated frequency (percent exceedence) of total CVP deliveries in the Northern and Southern CVP systems (excluding Madera and Friant-Kern systems) with 2000 level demands and D-1485 requirements.

CVP power generation facilities initially also were developed based on the premise that power could be generated to meet project use loads. The Reclamation Act of 1939 provided for surplus power to be sold first to preferred customers, including irrigation and reclamation districts, cooperatives, public utility districts, municipalities, and large educational or government facilities. Surplus commercial power may be sold to nonpreferred utility companies.

The California Independent Systems Operator (ISO) synchronizes all major electrical loads and generators within State boundaries to operate as a single cohesive system. In addition to the California ISO, a much broader system of electric generation and transmission exists with the CVP and SWP interact called the Western Systems Coordinating Council (WSCC). These interactions with the WSCC could extend over the entire West Coast and inland to the desert regions of the Southwest.

Other major hydroelectric facilities present in the study area are investor-owned utility companies, such as PG&E and Southern California Edison (SCE); owned by municipal agencies, such as the Sacramento Municipal Utility District (SMUD); and owned by several water and irrigation districts. Some of the larger facilities outside the CVP and SWP systems in the Sacramento Valley area include PG&E's Pit System (317 megawatt (MW)) and McCloud-Pit System (340 MW) in Shasta County, PG&E's Upper North Fork Feather River System (340 MW) in Plumas County, SMUD's Upper American River Project System (640 MW) in El Dorado County, and Yuba County Water Agency's Yuba River Project (300 MW) in Yuba County.

Hazardous Materials and Waste

Types of hazardous waste sites in the Sacramento River basin include contaminated agricultural ponds; hazardous materials spills; and leaking tanks or pipelines from industrial sites, railroad operations, commercial sites, and mining. Metals such as cadmium, copper, mercury, and zinc are present in inactive and abandoned mines in the Sacramento River drainage. Inactive underground mines and surface waste piles at Iron Mountain, California, in the Clear Creek watershed, have extremely acidic drainage with high concentrations of toxic discharges and metals.

Fire Hazard

Fire suppression policies and large-scale grazing have caused the rate of material decomposition to decline dramatically, and have led to fuel accumulation throughout most of the wild lands of the Sacramento River basin. Fire suppression efforts also have reduced the frequency of wildfires and greatly reduced land areas impacted by fires.

Natural Resources

The State's scenic beaches and mountains, mild climate, extensive rivers with cold water fisheries, fertile soil, and forested areas have been a major factor behind the in-migration of persons from other areas. The soil and climate of the Central Valley have brought about its development as a major agricultural area specializing in fruits, vegetables, rice, and other farm products. Farm production, in turn, has stimulated development of food processing establishments and businesses that provide services for area farms. Similarly, extensive timber resources have been the catalyst behind the growth of the Central Valley's lumber and wood products manufacturing. Development of Shasta Lake has resulted in Shasta County becoming a major outdoor recreational area that attracts significant numbers of recreationalists who reside outside Shasta County.

Aesthetics

Visual resources in the Sacramento River valley are characterized by agricultural uses in the valley, grasslands, and woodlands in the foothills, and forests in the upper watersheds. The Sacramento Valley's upper watershed has retained its oak woodland, grasslands, forests, and small rural communities despite substantial development along Federal and State highways in the foothills and mountain areas. These areas are framed by the forested ridgelines of the Sierra Nevada to the east, the Cascade Range to the north, and the Coast Ranges to the west. Little urbanization in these areas has preserved pristine wildernesses, mountains, and other dramatic landscapes.

Shasta Lake adds visual variety to this region. Viewer sensitivity is high in this area because of high recreation use and easy public access. A scenic highway is a road designated by the State or local agencies as having exceptional scenic qualities or affording panoramic vistas. Highway 151 (from Shasta Dam to near Summit City) is officially designated a State scenic highway.

Cultural Environment

The cultural environment elements described in this section include paleontology, archaeology, history, and ethnography.

Paleontology

California is geologically diverse, with metamorphic and intrusive and extrusive igneous rock formations, and a wide range of fossil-bearing sedimentary rock formations. Within the Shasta Lake area, metasedimentary and metavolcanic formations and more recent volcanic deposits occur. Sedimentary deposits are prominent in the area. The Triassic Hoselkus Limestone contains marine invertebrates such as ammonites, and marine vertebrate remains, including icthyosaurs and thallatosaurs. Solution caves in the Permian McCloud Limestone contain a significant Pleistocene fauna, including remains of horses, bison, giant bears, dire wolves, ground sloths, and mammoths.

Archaeology

California is rich in both prehistoric and historic archaeological remains. The Central Valley is an especially productive region for archaeological remains, with many deeply stratified sites that have produced information of crucial importance in understanding the prehistory of the state. The Shasta Lake area was little known until quite recently, and into the 1950s, it was believed that the area was unoccupied prior to A.D. 900, after which the Shasta area was occupied primarily by ancestors of the Wintu people. Subsequent investigations have revealed repeated occupation of the area as early as 8,000 years ago. Archaeological remains have been found that also represent ancestors of the Yana people. Historic archaeological sites represent remains from various historic era activities in the Shasta Lake region, especially relating to fur trapping, mining, early settlement, and agriculture (farming and ranching).

The Shasta Reservoir area has been surveyed for archaeological remains on numerous occasions. Thirty-seven sites were recorded in the 1940s prior to construction of Shasta Dam, but it is doubtful that this constituted an intensive survey by contemporary standards. During a drought in 1976-1977, USFS revisited previously recorded sites, and surveyed areas usually inundated, but again it is unclear whether this was a complete survey. Areas above gross pool apparently have been surveyed haphazardly and surveys are highly incomplete.

From available information, it is estimated that there are at least 118 archaeological sites believed to be inundated by Shasta Reservoir at gross pool elevation (1,076 feet). Of these, an estimated 76 sites are below gross pool but above the minimum pool elevation (840 feet). Of the 118 sites, the great majority (101) are prehistoric sites. Also, 7 historic sites and 10 multi-component (prehistoric/historic) sites are present. Around the reservoir, to elevation 1,276, are an additional estimated 55 archaeological sites. Of these, 50 are prehistoric sites, 4 historic are sites, and 1 is a multicomponent site.

History

Northern portions of the Central Valley are largely unmentioned in records of the Spanish and Mexican-era activities that occurred in the more southerly coastal portions of the state. The earliest historic records pertaining to the Shasta Lake area are from Hudson's Bay Company fur trappers. Malaria, introduced by fur trappers in the area, had devastating effects on aboriginal populations. Gold, copper, and iron mining were important activities in the Shasta Lake area during the latter half of the nineteenth century, and later activities included settlement by farmers and ranchers. Most known historic archaeological sites are related to mining, transportation, commerce, and recreation.

Historic sites include historic buildings and lodges and historic hiking and fishing trails. On the McCloud River, a private fly-fishing club has been in operation since 1904; its lodges date from the 1860s. Some lodges are likely eligible for inclusion in the registers of national and State historic structures.

Ethnography

California is home to many linguistically and culturally diverse Native American groups. Within the Shasta Lake area, archaeological and ethnographic sites include Indian villages, locations where ceremonies were held, burial grounds, and a number of other types of sites. Large portions of the Sacramento River, McCloud River, and Squaw Creek watersheds were known to have populations of the Wintu Tribe. Sites are known to occur on lands adjacent to Shasta Lake. The Wintu Tribe is a group whose language belongs to the Penutian family. These people are believed to have arrived in California around 1,000 B.C. The Wintu lived primarily in large villages along the rivers in their territory; they fished for chinook salmon in the McCloud and Sacramento rivers, and hunted deer and other animals. They also ate large quantities of acorns and other vegetable foods. Several local groups lived within the Shasta Lake area, including the Nomtipom, the Winnemem, and the Waimuk.

The Okwanuchu were a group, related to the Hokan-speaking Shasta people of southern Oregon, that lived in the McCloud River drainage Another distinct group was the Madesi band of Achumawi, farther east along the Pit River. In addition, the Central Yana people held territory in the Cow Creek drainage.

Numerous sacred sites are located immediately above the existing gross pool of Shasta Reservoir. These include burials and cemeteries, places of spiritual power, named villages, and other sites of special concern. The California Native American Heritage Commission identified a number of locations of particular concern.

FUTURE WITHOUT-PROJECT BASELINES

Identification of the magnitude of potential water resources and related problems and needs in the study area is not only based on the existing conditions described in this chapter, but also on an estimate of how these conditions may change in the future. Two baselines were identified to help define the extent of potential resources problems/needs and for use in identifying the relative effectiveness of alternative plans to be formulated to address these problems/needs:

- **California Environmental Quality Act Baseline** – This baseline is important for developing the EIR to meet requirements of CEQA. Under this baseline, future conditions are assumed to be equal to existing conditions.

- **National Environmental Policy Act (NEPA) Baseline –** Under this without-project future condition, only actions reasonably expected to occur in the future would be included. This would include projects and actions that are currently authorized, funded, permitted, and/or highly likely to be implemented. The NEPA Baseline is important for developing the EIS to meet the requirements of NEPA. The NEPA Baseline includes the CEQA Baseline for existing conditions.

Predicting future changes to the physical, biological, social, and economic environments in the study area, without a potential action to resolve the problems and identified needs in the study, is complicated by ongoing programs and projects primarily related to CALFED and the CVPIA. Accordingly, although not authorized or under construction, ongoing ecosystem restoration efforts are likely to be implemented through various small projects. Collectively these efforts would improve the quantity and value of freshwater emergent marsh, scrub-shrub, riparian, oak woodland, annual grasslands, agricultural habitat, wildlife, fishery and aquatic resources, and special-status species. Much of this improvement would be based on separate opportunities that are not integrated in a single plan.

Several significant projects that are expected to be implemented in the future in and near the primary study area, and to be included in the NEPA Baseline (for consideration in both conditions with or without a modification of Shasta Lake) include the following:

- **Sacramento River National Wildlife Refuge –** This is a land acquisition and habitat restoration program along the Sacramento River between Colusa and Ord Bend.
- **Folsom Modifications –** Modifications consist of enlarging existing outlets and constructing new low-level outlets to increase releases during lower pool stages, and revising the surcharge storage space in the reservoir.
- **Environmental Water Account –**EWA is a cooperative short-term management program to provide protection to fish of the Bay-Delta estuary through changes in SWP/CVP operations with no uncompensated water costs to project water users. The program appears to be very successful and it is believed that in some form of will continue into the long-term future.
- **Water Use Efficiency –** CALFED seeks to accelerate implementation of cost-effective actions of its water use efficiency (WUE) program to conserve and recycle water throughout the State. As with EWA, it is believed that some form of this program will develop and continue into the long-term future.
- **South Delta Improvements –**DWR and Reclamation are responsible for implementing CALFED's South Delta Improvements Program (SDIP). The SDIP includes providing for more reliable long-term export capability by State and Federal water projects, protecting local diversions, and reducing impacts on San Joaquin River salmon. Specifically, the CALFED actions in the SDIP include placing a fish barrier at the head of Old River, constructing up to three hydraulic barriers in south Delta channels, dredging and extending some agricultural diversions, and increasing the diversion capability of the Banks Pumping Plant at the Clifton Court Forebay from 6,680 cfs to 8,500 cfs during certain periods. The potential project is still in the planning phase and not yet approved. Accordingly it will not be included as a without-project condition in the SLWRI. However, because it is an essential

element of the ROD and has broad State and Federal agency support, there is a strong likelihood that it will be implemented in the future. Accordingly, the potential influence on the plan formulation process in this report of increasing the pumping capacity at Banks to 8,500 cfs is included as a sensitivity analysis in Chapter IX (Special Topics).

- **Trinity River Restoration Plan –** It is expected that over time, elements of the December 2000 ROD for the Trinity River Restoration Plan will be implemented. This includes reducing annual exports of Trinity River water to the Sacramento River from 74 percent of Trinity River flow to 52 percent.
- **Phase 8 Short-Term Agreement –** It is highly likely that some of the 45 projects identified in the Phase 8 Short-Term Settlement Agreement will be implemented, including dedication of a portion of 185,000 acre-feet of water for environmental needs. It is likely that the portion of this water not requiring construction of new infrastructure will be made available.
- **Operation Criteria and Plan –** Numerous actions contained in the 2004 revision to the 1992 OCAP will be implemented to address how the CVP and SWP would be operated in the future as several projects come on-line and as water demands increase.
- **Other Projects –** Various other projects and programs are expected to be implemented in the future, including the Battle Creek Restoration Project, CVP Contract Renewals, and further implementation of CVPIA (b)(2) water accounting.

FUTURE WITHOUT-PROJECT CONDITIONS

Summarized below are some of the expected physical, environmental, and socio-economic conditions generally expected to occur in the future in the study area.

Physical Environment

Basic physical conditions in the study area are expected to remain relatively unchanged in the future. No changes to area topography, geology, and soils, are foreseen. From a geomorphic perspective, ongoing restoration efforts along rivers are expected to marginally improve natural riverine processes. Without major physical changes to the river systems, which are unlikely, hydrologic conditions will probably remain unchanged. There is some speculation that the region's hydrology could be altered should there be significant changes in global climatic conditions. Scientific work in this field of study is continuing.

Much effort has been expended to control the levels and types of herbicides, fungicides, and pesticides that can be used in the environment. Further, efforts are underway to better manage the quality of runoff from urban environments to the major stream systems. However, water quality conditions are expected to generally remain unchanged and similar to existing conditions. Most of the air pollutants in the study area will continue to be influenced by both urban and agricultural land uses. As the population continues to grow, with about 4 million additional people expected in the Central Valley by the year 2020, and agricultural lands converted to urban centers, a general degradation of air quality conditions could occur.

Biological Environment

Significant efforts are underway by numerous agencies and groups to restore various biological conditions throughout the study area. These efforts include elements of the CALFED programs, the Upper Sacramento River Conservation Area program, efforts by TNC and other private conservation groups, and numerous other programs and projects. Accordingly, major areas of wildlife habitat, including wetlands and riparian vegetation areas, are expected to be protected and restored. However, as population and urban growth continues and land uses are converted to urban centers, many wildlife species especially dependent on woodland, oak woodland, and grassland habitats may be impacted.

Efforts are also underway to implement programs and projects to help restore fisheries resources. Although significant increases in anadromous and resident fish populations in the Sacramento River are likely to continue through implementation of projects such as the Battle Creek Restoration Project, some degradation will likely occur through actions such as reduction in Sacramento River flows and resulting elevated water temperatures due to reduced diversions of cooler water from the Trinity River. Accordingly, populations of anadromous fish are expected to remain generally similar to existing conditions.

Through the significant efforts of Federal and State wildlife agencies, populations of special-status species in the riverine and nearby areas will generally remain as under existing conditions.

Social and Economic Environment

The population of the State is estimated to increase from about 35 million in 2000 to about 46 million by 2020, and to nearly 60 million by 2040. The population of the Sacramento and San Joaquin River basins portions of the Central Valley is expected to increase from approximately 4.4 million people in 2000 to about 7 million people by 2020 and 10 million in 2040. In the Sacramento River basin, the population is expected to increase from about 2.6 million to about 3.8 million by 2020 and 5 million by 2040. To support these expected increases in population, some conversion of agricultural and other rural land to urban uses is anticipated. Also to accommodate the increasing population, modification of existing major traffic corridors is anticipated. Increased transportation routes are likely to be constructed to connect the anticipated population increase in the Central Valley to existing transportation infrastructure.

Anticipated increases in population growth in the Central Valley will result in increased demands on water resources systems for additional and reliable water supplies, energy supplies, water-oriented facilities, recreational facilities, and flood damage reduction facilities.

Table III-13 summarizes Bulletin 160-98 estimated water demands (applied water), supplies, and potential shortages for 2020 levels of demand in the Sacramento River and San Joaquin River basins and for the State of California. As shown in the table, estimated future shortages of water supplies in drought years are expected to equal about 1.7 MAF in the Sacramento River and San Joaquin River basins and 6 MAF for the State. However, for many of the reasons mentioned in the existing conditions discussion, it is believed that the potential water shortages under 2020 demands will be significantly greater than shown in **Table III-13**.

Anticipated increases in population growth also will have impacts on visual resources within the Central Valley, as areas of open space on the valley floor are converted to urban uses. These increases also will result in increased demands for electric, natural gas, water, and wastewater utilities; public services such as fire, police protection, and emergency services; water-related infrastructure; and communication infrastructure. Further, the increasing population will increase the potential for hazardous toxic radiologic waste issues in the future. In addition, it will place pressures on preservation of existing historic and prehistoric cultural sites within the study area

TABLE III-13
ESTIMATED WATER DEMANDS, SUPPLIES, AND SHORTAGES FOR 2020

	Hydrologic Basin							
	Sacramento River		San Joaquin River		Two Basin Total		State of California	
Item	Average Year	Drought Year	Average Year	Drought Year	Average Year	Drought Year	Average Year	Drought Year
Population	3.8		3.0		8.8		45.6	
Urban Use Rate (GPCPD)	267	289	282	286	273	288	235	242
Acres In Production (mil)	2.2		1.9		4.1		9.2	
Agricultural Use (AFPA)	3.7	4.1	3.3	3.5	3.6	3.9	3.4	3.5
Applied Water (MAF)								
Urban	1.1	1.2	1.0	1.0	2.1	2.2	12.0	12.4
Agricultural	7.9	8.8	6.5	6.7	14.4	15.5	31.5	32.3
Environmental	5.8	4.8	3.4	1.9	9.3	6.1	37.0	21.3
Total	***14.9***	***14.3***	***10.8***	***9.6***	***25.7***	***23.9***	***80.5***	***66.0***
Water Supply (MAF)								
Surface Water	12.2	10.0	8.5	6.0	20.7	16.0	65.0	43.3
Groundwater	2.6	3.3	2.3	2.9	4.9	6.2	12.7	16.0
Recycled/Desalted	0	0	0	0	0	0	0.4	0.4
Total	***14.9***	***13.3***	***10.8***	***8.9***	***25.6***	***22.2***	***78.1***	***59.8***
Shortage (MAF)	***85***	***1.0***	***0.1***	***0.7***	***721***	***1.7***	***2.4***	***6.2***

Key: AFPA – acre-feet per acre GPCPD – gallons per capita per day MAF – million acre-feet mil – million

Source: The California Water Plan, Bulletin 160-98, Appendix 6A, Regional Water Budgets with Existing Facilities and Programs, November 1998.

The increase in population and aging "baby boomer" generation will increase the need for health services. During the 2000-2010 decade, many workers will reach 60 years and older. The general migration of retirees and older Americans from colder northeastern regions to warmer southern regions is expected to continue. While many of the region's high school graduates will leave the area for colleges and jobs located in San Francisco and southern California, the region's superior outdoor recreational opportunities and moderate housing opportunities are expected to attract increasing numbers of retirees from outside the region. Increasing numbers of residents, in turn, will produce increased employment gains, particularly in the sectors of retail sales, personal services, finance, insurance, and real estate.

Cultural Environment

Any paleontological, historic, archeological, or ethnographic resources currently being affected by erosion due to reservoir fluctuations would continue to be impacted. Fossils and artifacts located around the perimeter of the existing reservoir will continue to be subject to collection by recreationalists. Resources located within the potential inundation zone of an enlarged Shasta Lake will likely be unaffected.

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